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OPERATING EXPERIENCES AND ECONOMY OF A DIESEL ENGINE DRIVEN PUMPING STATION[1]

BY W. DEWITT VOSBURY[2]

A Diesel engine driven pumping station is a comparatively new idea in water works practice. Whether or not this type of plant has come to stay depends, in great measure, upon two principal factors: namely, reliability and economy. Reliability has been fairly well demonstrated by the successful and rapidly increasing application of internal combustion engines to the propulsion of ships.

The efficiency of Diesel engines is well known. It is not generally recognized, however, that this engine differs from steam as a source of power in that the efficiency of a unit is independent of its size. In other words, approximately the same thermal efficiency is gained from Diesel engines regardless of the indicated horse power, whereas large units are necessary for maximum efficiency with steam. For moderate size pumping stations, Diesel engines, therefore, have an advantage over the latter as a source of power.

In considering the over-all economy of the Diesel engine for pumping purposes it is necessary to take into consideration such factors as the relatively high capital cost, maintenance, load factors and the cost of power from other sources. All of these considerations were carefully weighed before the adoption of Diesel engines for the new pumping station at Gloucester, New Jersey; the operation and economy of which will presently be described.

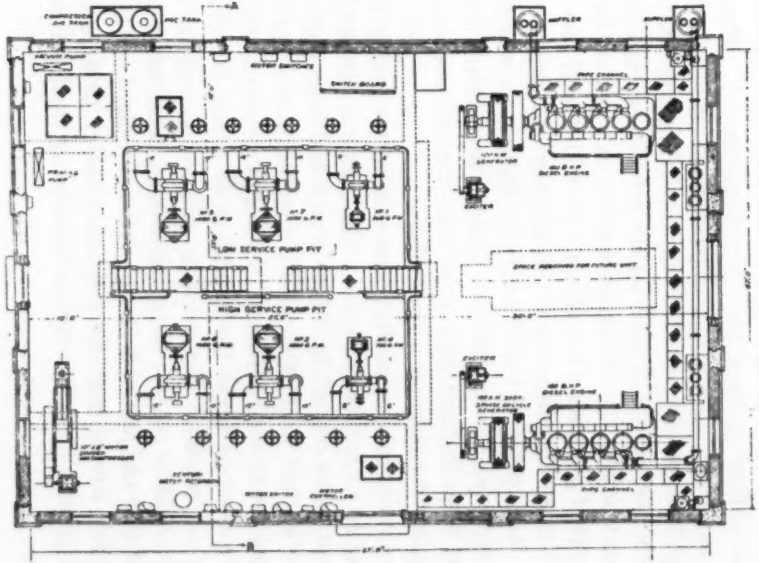
[1] Presented before the New York Convention, May 23, 1924.
[2] Consulting Engineer, Camden, N. J.

The original plant had a capacity of 2,000,000 gallons per day. It was steam driven and constructed in 1883. Water was raised by compressed air from approximately twenty driven wells and discharged into a receiving basin. From the latter it was pumped to an iron removal plant consisting of an aerator and sand filters. After filtration it was pumped for the third time into the distribution system. Most of the equipment was inefficient and badly in need of repair or replacement. As a consequence operating expenses were excessive, amounting in 1921 to $36,000. In addition, the supply of water was inadequate. It was clear, therefore, that in remedying the situation, any general scheme of improvement should first recognize the necessity for an ample supply of water and, second, a reduction in operating expenses.

From a series of tests it was determined that with six to eight wells of a new type, it would be entirely feasible to pump all water required by direct suction at a maximum draft below the ground surface of not exceeding 30 feet. It was, therefore, decided to lift the water from the wells to the filter plant by pumps installed in a suitable pit. Owing to the depth of the pit required, it was desired to keep it as small as possible to avoid excessive construction costs. The practical limits of the pit eliminated the use of high duty pumping engines. Steam, turbine-driven, centrifugal pumps were considered. It was found, however, that they could not be used, due to low power requirements and consequent necessity of operating them without condensers. Further investigation, which took into consideration the necessity of replacing all old equipment, as well as economy in first cost and efficiency in operation, led to the decision to adopt motorized centrifugal pumps and to construct an entirely new, electrically-driven pumping station. Following this the cost of current from other sources, together with the capital cost of a standby unit, was compared with the cost of current generated by high-economy, internal-combustion engines. The comparison was found to be in favor of the latter. Full-type Diesel engines, direct connected to generators were therefore adopted as prime movers.

The new plant was completed and placed in operation in September, 1922. It has a pumping capacity of four million gallons per day. The power and pumping equipment consists of two Diesel engine-driven generating units; three low-lift and three high-lift horizontal, single stage, centrifugal pumps; a compressor for furnishing air under pressure to clean the wells and two vacuum pumps for main-

PLAN OF STATION



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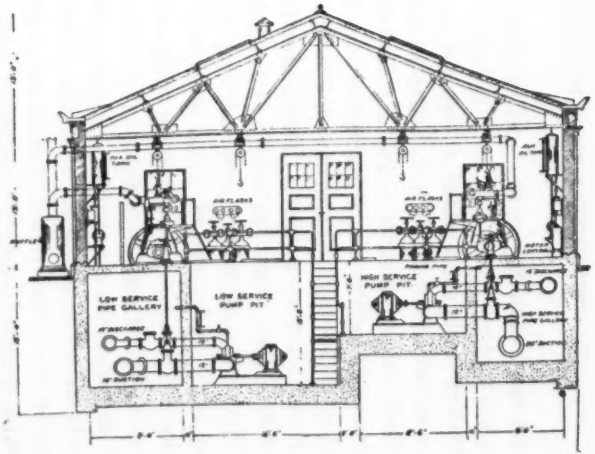

taining a constant vacuum on the suction line. The pumps and compressors are motor driven.

The generating units are located at one end of the building with sufficient space between for the installation of a third engine when required. Each unit consists of a 180 h.p., vertical, four cylinder, full-type Diesel oil engine, direct connected to a 120 kw, revolving-field generator. The engines operate at 300 r.p.m. Three phase, 60-cycle, 240-volt current is used. Storage for fuel oil is provided by two 11,000 gallon tanks buried in the ground outside of the building. The oil is pumped by hand, as required, from the storage tanks to two small tanks, one of which is located on the wall back of each engine. From the latter it flows by gravity and is injected into the cylinders by air under a pressure of from 60 to 70 atmospheres.

As before stated, there are two sets of pumps; one for low-service from the wells to the filter plant; the other for high-service from the clear water reservoir to the distribution system. Each set consists of three pumps having a capacity of one, one and one-half and two million gallons per day respectively. This combination of capacities provides pumping rates of from one to 4.5 million gallons per day at intervals approximating 500,000 gallons. The two largest pumps of each set are inter-connected for operation in tandem whereby the discharge pressure can be doubled.

Both sets of pumps are located in a pit which is 27 feet square and of two depths; the deeper half being occupied by the low-service pumps. At opposite sides of the pit are galleries in which the rather complicated piping is concealed. Operation of valves and pumps is controlled from the floor above, so that it is not necessary to enter the pit except for inspection and oiling.

It was natural to surmise that some difficulty would be experienced in starting up a plant of this type. The expected difficulties failed to materialize, however, while others which had been entirely unforeseen gave a great deal of trouble. The old station had a crew of fifteen men consisting of firemen, oilers and steam engineers with no experience whatsoever in the operation of either Diesel engines or electrical equipment. For certain reasons no radical change in personnel could be made. Seven men were, therefore, selected from those available and placed in charge of the new plant. This was done without their having had any previous training or experience other than that gained while the engines were being tried out and tested.

When the station was first placed in service the men had considerable difficulty in changing over from one pump to another, or in placing an additional pump in operation. This was due to the load increasing much more rapidly than the engine could handle it. As a result there would be a sudden drop in voltage, following which the pump speed would be reduced. The reduction in speed would often reach the point where either or both pumps would drop their suction.

The engines were guaranteed to operate from no load to full rated capacity without exceeding 3 per cent each way from mean speed, providing the change in load was not made too rapidly. A method of gradually building up the load or its equivalent was finally worked out. This consists in first priming the pump to be placed in operation. The motor is then started and gradually brought to speed during which the discharge valve is slowly opened and the voltage adjusted at the switch board. The whole operation requires from one to two minutes, depending upon the increase in power consumption and the proportion which it bears to the total load.

During the first few weeks the most serious situation encountered was the entire lack of confidence which the men had in the reliability of the plant. Primarily they were steam engineers and, as such, they viewed any change from the old order of things as one to be looked upon with distrust. In addition, there were more men in the old plant than could be used in the new. Some were sure to lose their positions and they did not hesitate to circulate rumors which eventually gained a foothold with the public. So strong became the general belief that the new plant would prove to be unreliable, it was decided not to dismantle the old station but to hold it in reserve against the day required. Unfortunately for the reputation of the old plant, this day came all too soon. A final change was necessary in the main discharge piping between the two stations. While under way it was decided to shut down the new station and run the old. Much to the surprise and chagrin of the supporters of the old plant it was found that it could not be run. Like the famous one-hoss shay, it had outlived its useful life and collapsed beyond repair. With its passing went all lack of confidence in the new station. It had to be run and it did run. During the period of twenty months which has elapsed since that time no shut-down has occurred; the supply of water has been ample; the pressure has been constant and the men who operate the plant now have entire confidence in it.

Of the two engines one only has given any trouble. This took the form of frequent changes in speed which appeared to be fairly periodical and affected the pumps in the manner already described. Each time this engine was placed in operation it would run at constant speed for a period of time, varying from a few hours to several days. Periodical fluctuations in speed would then begin to occur with increasing frequency until it would finally become necessary to shut the engine down for overhauling. Upon pulling out the exhaust valves they were always found to be heavily carbonized and badly in need of regrinding. It was thought at first that the trouble was due to some defect in the governor. It was finally traced, however, to the collection of very minute particles of sand and scale on the seat of the fuel oil pump which regulates the quantity of oil injected into the cylinders at each stroke. The presence of the foreign matter was a mystery. Apparently every precaution had been taken to prevent just such an occurrence. The fuel supply lines had all been carefully washed out and drained. The oil itself had been tested for suspended matter. There was also a standard make of strainer through which all oil had to pass before reaching the engine.

After a great deal of experimenting, the source of the scale was located in the oil piping of seamless, drawn, steel tubing and was due to the fact that the pipe had not been pickled. The fine grit came from the interior of the gravity tank where it was found adhering to the galvanized surfaces. The filter had failed to catch and hold this material although the oil was required to pass through several thicknesses of cloth stretched over the surface of a gauze strainer.

The foregoing is the only difficulty which has been encountered in the operation of either engine to date. The plant has now been in constant service, twenty-four hours a day, since September, 1922. The engines are running alternately and are kept in operation until the valves need regrinding, which is required at intervals of from six to eight weeks. When shut down, it takes from one to two days to regrind the valves and to make such slight adjustments as are necessary. This is the only time there is sufficient work about the plant to keep more than one man busy.

One of the two engines was recently given a thorough inspection. It has been in service approximately 300 days, or a total of 7200 hours. Very litle wear of moving parts was found. All bearings were in excellent shape and a surprisingly small amount of carbon was found in the cylinders.

In view of the preceding, the experience gained in the operation of Diesel engines at this particular plant would indicate the following:

1. The reliability of Diesel engines is sufficiently well established to justify their use as prime movers for pumping stations of moderate size.

2. They can be operated, if necessary, by untrained men, although this is not advised. One man, at least, should be an experienced Diesel engine operator.

3. They are sensitive to sudden changes in load. This characteristic may become the source of a great deal of trouble and annoyance if provision is not made to avoid it.

4. Expected high maintenance costs have failed thus far to materialize since nothing to date has been spent for repairs. The indications are that the useful life of the engines will be between fifteen and twenty years and that annual maintenance will not exceed 2 per cent.

5. Every precaution should be taken to eliminate all foreign matter from the fuel oil before entering the engine. This should be accomplished, first, by thoroughly pickling and cleaning the fuel supply piping before the engine is placed in operation; and second, by the use of a number of fine strainers covered with Scotch muslin, Turkish toweling or other similar fabric.

6. Attention should be given to the quality of both fuel and lubricating oil. Individual shipments of fuel oil will vary considerably in chemical composition, suspended matter and total residue. It is best to sample and test each consignment. Only a high grade lubricating oil and one recommended by the engine manufacturer should be used A poor oil, or one not adapted to the particular type of engine, will cause trouble through excessive wear and carbonization.

The engines were purchased under a guaranteed consumption of 0.48 pounds per brake-horse-power-hour, with fuel oil of not less than 18,500 B.t.u. per pound. This is equivalent to 0.065 gallons per b.h.p.-hr. The actual amount used has been slightly under this, or 0.0624 gallon. This has been probably due to the use of a better grade of oil than that specified.

Consumption of lubricating oil was guaranteed not to exceed 0.6 of a gallon per 1000 rated horse-power-hours, with engine operating at not less than three-quarters load. Up to the present time the engines have been operating at 60 per cent of full load and the consumption of lubricating oil has averaged 0.66 gallon. Fuel oil

delivered at the plant costs 5.3 cents per gallon. In 1923 the lubricating oil used cost 65 cents per gallon. The cost of power for fuel and lubricating oil has, therefore, been 3.74 mills per brake-horsepower-hour, or 5.6 mills per kilowatt hour.

TABLE 1

Annual cost of capital and depreciation

ITEM NUMBER	STRUCTURES AND EQUIPMENT	COST NEW	USEFUL LIFE IN YEARS	ANNUAL DEPRECIATION CHARGES COMPOUNDED AT 4 PER CENT
1	Building and foundations	$32,000	40	$ 336.64
2	Motor pumps and other equipment	22,000	15	1,098.68
3	Engines and generators	43,500	15	2,172.39
4	Station piping	11,000	40	115.72
5	Oil storage tanks	2,000	15	99.88
Totals		$110,500		$3,823.31

(*a*). Cost of capital invested in plant with interest at 5 per cent—	
$110,500 @ 5 per cent	$5,525.00
(*b*). Annual cost of depreciation compounded at 4 per cent	3,823.00
Total fixed charges	$9,348.00

TABLE 2

Annual operating costs, 1923

ITEM	KIND OF EXPENSE	ANNUAL COST
1	Labor and salaries	$ 9,900.00
2	Fuel oil, 68,255 gallons @ 5.3 cents	3,617.52
3	Lubricating oil, 730 gallons @ 65 cents	474.50
4	Coal for heating	225.00
5	Maintenance and repairs	254.00
6	Supplies and miscellaneous expenses	141.00
Total operating costs		$14,612.02

During the year of 1923 731,000,000 gallons of water were pumped, or an average daily pumpage of 2,000,900. This is about one-half the capacity of the plant. All of the water was pumped twice; first, by the low-lift pumps under a head of 40 feet, and, second; by the high-lift pumps at 106 feet. This fact should be borne in mind when comparing the cost with other stations pumping under but one head.

In the tables, the cost per 1000 gallons of water pumped and delivered to the city mains is calculated with all fixed and operating charges included. The cost of constructing the station was $110,500. Annual interest at 5 per cent on capital invested, therefore, amounts to $5525. The sinking fund charge, calculated upon a

TABLE 3

Cost of water delivered to mains, 1923

Average daily pumpage	2,000,900 gallons
Total water delivered to mains in 1923	731,000,000 gallons
All water pumped twice:	
a. Total low lift head	40 feet
b. Total high lift head	106 feet
Total cost:	
a. Fixed charges, table 1	$9,348.00
b. Operating costs, table 2	14,612.00
Total cost	$23,960.00
Cost of water delivered to mains:	
a. Fixed charge cost per 1000 gallons	$.0128
b. Operating cost per 1000 gallons	.0200
Total cost per 1000 gallons	$.0328

TABLE 4

ITEM	KIND OF EXPENSE	ANNUAL COST
1	Labor and salaries	$9,900.00
2	Fuel oil 102,382 gallons @ 06 cents	6,142.92
3	Lubricating oil 1095 gallons @ 65 cents	711.75
4	Coal for heating	225.00
5	Maintenance and repair	1,170.00
6	Supplies and miscellaneous	211.50
	Total operating cost	$18.361.17

Estimated cost of pumping	3,000,000 gallons daily
Total water pumped per year	1,095,000,000 gallons
All water pumped twice:	
a. Total low lift head	40 feet
b. Total high lift head	106 feet

basis of 4 per cent interest compounded annually, with useful life assigned to engines and other equipment of but fifteen years, amounts to $3823. The total annual fixed charge is, therefore, the sum of the interest and sinking fund, or $9348. The operating cost for 1923

was $14,612 and was made up by $9900 for labor and salaries; $3617 for fuel oil; $474 for lubricating oil and the balance for heating, repairs, supplies and miscellaneous expenses. The sum of the fixed charges and operating costs for the year amounted to a total of $23,960. On the foregoing basis, the fixed charge cost per 1000 gallons of water is $0.128, while the operating cost amounts to $.020, making a total of 3.25 cents per thousand gallons of water pumped.

The above figures are based upon pumping at one-half capacity; to the operating cost of which must be added the total fixed charge. If the station was operated at the rate of 3,000,000 gallons per day, or three-quarters of full capacity, the fixed charges and labor costs

TABLE 5

Cost of water delivered to mains

Total cost:	
a. Fixed charges, table 1	$ 9,348.00
b. Operating cost, table 4	18,361.00
Total cost	$27,709.00
Cost of water delivered to mains:	
a. Fixed charge cost per 1000 gallons	$.00854
b. Operating cost per 1000 gallons	.01677
Total cost per 1000 gallons	$.02531

would remain the same. The only change would be for additional fuel and lubricating oil, plus a proportionate increase in the cost of repairs and supplies. Although no such expenditure has yet been made, a charge of 2 per cent of the engine cost should also be included for their maintenance. With these items of additional expense allowed for, the cost of the two pumpings at the rate of 3,000,000 gallons per day should not exceed the sum of $.025 per thousand gallons of water delivered to the city mains.

DISCUSSION

MR. C. M. EVERETT:[3] The value of the Diesel engine as a means of driving pumps has not been sufficiently realized, but there are indications that this type of prime mover will become better known. There is already considerable interest being displayed by waterworks men, due probably to the increase in the cost of coal and of labor.

[3] Of Hazen and Whipple, New York, N. Y.

Diesel engines do not require much of an operating force, and at present average prices of coal the cost of oil for running a Diesel engine driven pump is less than the cost of coal for running anything but the largest and most efficient steam pumps.

The City of New Britain, Connecticut, has a Diesel engine driven pump in their White Bridge Pumping Station. This station was designed in this office and constructed in 1922 and 1923. The White Bridge Supply at New Britain is an emergency well supply intended to help out the main supply from impounding reservoirs in dry years. It consists of a line of twenty tube wells in a sand deposit about 40 to 50 feet deep, a concrete suction well about 50 feet in diameter with no bottom, and a pumping station with a single Diesel engine driven pump.

The wells are all connected to a cast iron header which discharges into the suction well through a vertical pipe extending down to a point near the bottom. The pump takes its suction from the opposite side of the well.

The water is thus siphoned out of the tube wells as the pump does not pull directly on the wells. As air collects at the top of the siphon it is removed by a vacuum pump. The main purpose of this arrangement is to keep the sand out of the pump suction, using the suction well as a settling basin for which purpose it has proved itself very efficient.

The suction well is also used as a means of getting water out of the sand. It is estimated that the yield of this concrete suction well amounts to about $1\frac{1}{4}$ million gallons per twenty-four hours.

The pump is a horizontal duplex plunger pump geared to a two-cylinder, two cycle, vertical, solid injection, full Diesel oil engine.

The pump has a capacity of 3 million gallons per twenty-four hours against a total head of 250 feet. The engine is 150 b.h.p. and runs at 275 revolutions per minute.

Various types of pumps and methods of driving them by the oil engine were considered for this installation. The type used was selected for the following reasons:

1. The plunger type of pump would operate under a high suction lift.
2. With nothing between the oil engine shaft and the pump shaft but a single gear, the overall efficiency is high.
3. The first cost is not high, considering the reliability of the type of drive and the high efficiency attained. A belt driven centrifugal unit would be cheaper and its efficiency would be good, but a belt was considered an undesirable feature in the plant at least for the main drive.

4. The unit is flexible. It will run smoothly at a capacity of 1.85 million gallons per day, and under this condition which represents half load on the engine, the overall efficiency of the engine and pump expressed as a duty of foot pounds of work done per pound of oil burned, was 83 per cent of the duty at full load.

This equipment has given good service since it was tested in June of last year. It is not run continuously, but is used only during the summer months. For this reason no duplicate was installed or considered necessary.

The total cost of the White Bridge supply was about $170,000. The well system with the suction well cost about $70,000, the pumping station with all equipment complete, about $60,000, and the remaining $40,000 was spent on the pressure main, the land, roads, etc.

The cost of operation is low. One man on a shift easily takes care of the whole outfit. One man of the operating force was trained in the factory where the Diesel engine was made and this is believed to be always desirable in operating a Diesel engine. It is not a vital requirement by any means, but it will save time and expense when troubles occur.

Oil is delivered at the station by oil trucks of the oil company. It cost 1 cent per pound in the tanks last summer. With oil at 1 cent per pound the cost of operation of the station, including labor is about $14.00 per million gallons of water pumped or about 5.6 cents per million gallons per foot. The fixed charges amount to about $4800 per year. On the basis of 120 days use of the source per year, this will amount to about 5.3 cents per million gallons per foot. This figure would be lower, of course, if the station were used more.

The total cost of water delivered to the mains is in the neighborhood of $.027 per thousand gallons, considering pumping station alone, and about $.05 per thousand gallons for the whole supply, for the whole cost including fixed charges.

CURRENT PRACTICE IN THAWING FROZEN SERVICES AND HYDRANTS

By F. A. McInnes[1] and J. M. Goodell[2]

Some water works have more trouble from frozen services and hydrants than have others in about the same latitude. This is due to differences in climate, soil and the protection against deep frost given by snow on the ground. There can be, therefore, no universally standard practice in thawing such services and hydrants. Each water works must adopt those methods of thawing which best meet the conditions due to freezing in the past. No practicable preventive measures to diminish the trouble have been found yet, while the experience of the winter of 1917–1918 indicates that the prompt removal of snow from street pavements and sidewalks may possibly increase somewhat the tendency for freezing to occur.

Where only a few service pipes are frozen during the average winter the customary method of thawing them is with hot water or low pressure steam, furnished by a small portable boiler which can be carried by two men into the basement of the building with the frozen service. These boilers are generally provided with kerosene burners. The service pipe is disconnected between the meter and shut-off valve, if the latter is of such a pattern that a small pipe to carry the steam or hot water can be passed through it when open.

In some cases it is necessary to take off the shut-off valve in order to insert the small pipe. When this is done, it may be desirable, in order to avoid unnecessary flooding of the basement floor, to shut the curb cock, thaw the service to that cock, and then open it just enough to see if the water will flow. If the ice has all been thawed so the service is clear, the curb cock can be closed while the pipe connections are made up again in the basement, and there will thus be no trouble with water pouring over the basement floor. If the service is found to be frozen between the curb cock and the main, then the curb cock must be opened and the small steam or hot water pipe pushed through the cock until the whole service is thawed.

[1]Consulting Engineer, Boston, Mass.
[2]Civil Engineer, Upper Montclair, N. J.

Where steam is used, generally under 3 or 4 pounds pressure, the steam outlet of the boiler is connected to a $\frac{3}{8}$-inch lead or $\frac{3}{16}$-inch block tin pipe which is slowly forced into the service at the point of disconnection in the basement. As soon as it is stopped by the ice, steam is turned on and as the ice melts the pipe is moved ahead gently. The steam condenses and flows back into the basement, where provision for catching it must be made in order to avoid flooding the floor.

Where hot water is used it is generally pumped from the boiler into the small thawing pipe by a hand force pump. The backflow of water from the service must be saved for boiler feed; if buildings are far apart considerable time may be lost in obtaining water to feed the boiler if the backflow is not saved, because much more water is needed for thawing by the hot water method than by the steam method.

The advantages of thawing by steam or hot water are that the apparatus is inexpensive, can be used by the water works employees without electrical training, and can be employed wherever boiler feed water is available. The disadvantages are slowness in thawing, compared with electrical methods, and the difficulty sometimes encountered in passing the small thawing pipe through the openings in cocks and valves. The method will probably continue to be used exclusively by those water works having only a few services frozen annually, except in those rare winters like that of 1917–1918, when the help of the local electric lighting utility can be enlisted in meeting such an unusual emergency, as explained later.

Where the annual number of frozen services is large, except in unusually open winters, the present tendency is toward the water department owning an electric thawing outfit. This generally consists of a gasoline engine mounted on skids with a dynamo driven by it. About 55 volts is desirable and the set should be able to deliver 15 to 35 kilowatts. There is usually a switchboard with cut-out switch, rheostat, voltmeter and ammeter. Sometimes the rheostat is merely a keg containing brine, with a metal plate on the bottom and another which can be raised or lowered so as to vary the depth of brine between the plates and consequently the resistance to the flow of the electric current from one plate to the other. This is called a water rheostat. The current passes from the dynamo to the rheostat, then through a covered cable, usually of No. 4–0 size, to a clamp on the frozen service pipe inside the building. The service pipe should

always be disconnected at the meter to prevent any possibility that the current used in thawing may flow into the plumbing system of the building. Neglect of this precaution has caused considerable trouble. The other side of the dynamo is connected to a hydrant by another cable. As a rule a current of 175 to 225 amperes and 15 to 20 volts is all that is necessary to thaw the average small service, but cases may arise with larger pipes where more current and somewhat higher voltages can be used safely. Great care must be taken in all electrical thawing that an unduly large current is not used in an effort to hurry up the work. While an overheated pipe line may not fail when it is put in use again, it is liable to do so later. Couplings of service pipes seem to be particularly subject to injury by heavy currents, probably because they offer greater resistance than does the pipe itself to the passage of electric currents and are heated higher than the pipe in consequence.

After the connections are made the actual thawing takes only 6 to 12 minutes with most small services. These outfits afford the quickest relief from frozen services which water departments can obtain and they can be used wherever a truck can go. They are relatively expensive, however, even when built of second-hand apparatus.

In some cities owning electric street sweeping machines, the storage batteries used on these machines have been taken out for emergency thawing work as a substitute for the engine-dynamo set just mentioned. The best method of connecting up the cells of such batteries depends upon the number and type of cells and the current desired. With storage battery outfits the water works superintendent should make very sure that the connections will not permit an excessive current to be delivered. A rheostat and ammeter should be provided and the outfit should be operated by a man who can be relied upon to use only suitable current. With these outfits 16 volts are enough for the average small service pipe. Where it is certain such batteries will be available for emergency use, the method of connecting and transporting them should be worked out carefully and the switchboard and cables provided before the need for them arises. It will be necessary, of course, for the water works superintendent to make sure that the cells are kept fully charged and ready for use during the period when freezing may occur. A battery must be recharged after a continuous day's use, the operation taking approximately eight hours time.

An outfit using an engine-dynamo set or storage battery, capable of being transported on a truck or sledge, is free from the limitations of electric thawing equipment deriving current from electric lighting circuits, which are not always within reach of the localities where thawing must be done. Nevertheless, the use of current from such circuits is a valuable emergency measure for which it is well to be prepared. The method consists in making temporary connections to the lighting circuits with cables which are run to transformers. These reduce the voltage to that required for thawing. The transformers are usually connected through a rheostat, ammeter, voltmeter and switches to cables which are attached to the frozen service and a hydrant, as already described. Sometimes the rheostat is omitted when it is known that the apparatus will be handled by careful, competent electricians who understand how to change the resistance of the cables by looping them; in such cases cables of No. 0 size are employed. It is questionable, however, whether the omission of the rheostat should be permitted on account of the danger of excessive currents flowing into the service through some oversight.

Some years ago several makers of transformers manufactured special pipe-thawing transformers, but the sale of them was so small that they are no longer made. One manufacturer states that they now usually recommend two 25 or 37½ kva. transformers with a low voltage of 110 volts and a high voltage conforming to that of the local electric lighting system. For example, they recommend that two 2300-volt transformers be connected in series on a 2300-volt line and the 110-volt windings be connected in parallel with each other, thus giving about 55 volts on the cables to be attached to the service and hydrant. For a main 6 inches or more in diameter, both the primaries and secondaries can be connected in parallel, giving 110 volts.

Distribution transformers suitable for this work are usually kept in stock by electric lighting utilities, so there is rarely any reason for a water department to buy them. Inasmuch as the connections with lighting circuits should be made only by employees of the electric utility, such an electrician should be a member of each gang using one of these transformer outfits. Present practice is for the water department to hire the equipment and electricians from the lighting utility as needed and add a water works foreman and laborers. Where such an outfit is used the electricians should be carefully instructed regarding the danger of using heavy currents.

When such equipment is connected to the lighting circuit and the frozen service, it will thaw the pipe just as quickly as a self-contained outfit will do the work. Its drawbacks are the time needed to make the connections with the lighting circuits in some cases and the occasional impracticability of making any connection at all. It is so effective, however, when properly used, that wherever emergency equipment is likely to be useful, it is advantageous to have it in readiness by mutual arrangement between the water and electric lighting officials, before severe cold weather arrives.

Thawing hydrants and their branches, like thawing large mains, requires equipment of greater capacity than is needed for thawing service pipes. When the work is done by steam, an upright boiler is generally used; sometimes an old fire engine is available for the purpose. The steam is delivered through a hose into one of the nozzles of the hydrant. If the branch is frozen, it is usually necessary to remove the hydrant and insert the steam hose into the end of the branch. Where a hydrant branch has once been frozen, the hydrant pot and branch should be lowered if this is possible. If the trouble is in the barrel, above the bottom valve, denatured alcohol or some other anti-freezing substance should be placed in the barrel.

When the hydrant and its branch are thawed electrically the currents are so heavy that only a thoroughly competent, careful electrician should be in charge of the electrical part of the work. In fact, wherever electrical thawing is practiced, care must be taken to prevent any annoyance to the public by straying currents, and the danger of causing a fire hazard or of damaging pipes, particularly pipe joints, by excessive currents must never be overlooked.

SOFTENING OF PUBLIC WATER SUPPLIES[1]

By Gale S. Strout[2]

It has been said that "It is almost an axiom that a good water supply is essential to the prosperity of a municipality." Such a statement made ten years ago would necessarily call for more limitations than a similar utterance today. The advancement made in the methods of rectification of waters for human consumption and general use in recent years would remove the necessity of limiting a general statement as above, and today it can be truthfully stated that it is a recognized axiom that good water is essential to the prosperity of a city and one of the prerequisites of a water supply. Until now, a good water supply has meant, in the majority of instances, an abundance of water, one free from turbidity and from disease-bearing germs. It should also be free from obnoxious odors and pleasant to the taste. A water with these qualifications was unquestionable. It is only natural that the question of sanitation was paramount and the first endeavors of the water companies were those looking toward the potability of the supply.

But civilization does not stand still. It either advances or goes backward and the public demands become more and more exacting. What may have been sufficient yesterday may fall far short of supplying the needs of today. If the proper steps have been taken to safeguard the consumer's health, the next step to be taken will be an economic one and his financial welfare must be attended to. Whether or not the water companies in rendering public service will voluntarily take the initiative and furnish a water free from hardening salts as well as one free from disease-bearing germs is problematic. I think that it can be truthfully stated that in America up until now, not a single water softening system has been put into operation for a municipal supply where the original supply was clear and clean and otherwise fit for human consumption, although the water itself was very hard. There have been a considerable number of cities, using

[1] Presented before the California Section meeting, October 26, 1923.

[2] District Manager, Water Softening Division, Wayne Tank and Pump Company, San Francisco, Cal.

the turbid waters of the rivers of the middle western states, which have resorted to purification, principally filtration, and as a by-product of filtration, have partially softened the water. There are others that have built fairly extensive water softening plants in conjunction with the filters and operated them extensively with gratifying results. Nevertheless the real pioneer among municipalities to actually soften a clear, clean and otherwise satisfactory but hard water is yet to be proclaimed.

Although the terms "hard" and "soft" waters are ones that we have all heard since our earliest recollections, they are only relative and the interpretation put upon them varies with the individual and the section of the country from which he comes. If a resident of Portland or Seattle were to speak of hard water, he would probably mean anything from 2 grains per gallon up, while some one from Coalinga mentioning soft water would probably mean anything below 30 grains. Nothing is large or small, tall or short, except by comparison. To a child, a man below the average height would appear tall. And so it is with waters. They are either hard or soft according to our established unit of comparison, and our established unit of comparison is undoubtedly that water with which we are most familiar. A citizen of Fresno is perfectly safe in boasting of his wonderful soft water supply to a man from Los Angeles or San Francisco, but he should be more reserved in his statements to his friends from Portland, Seattle or Long Beach. In order that I may show definite comparisons of waters of different degrees of hardness, I have here labeled samples of waters in bottles. These samples are,

1. Distilled water
2. Fresno City water
3. San Francisco Spring Valley Water
4. A San Francisco well water

In this case the distilled water is logically the basis of comparison because it is pure and therefore free from all salts as well as the hardening salts. It has (1) unit of soap, Fresno City water 9 units, San Francisco Spring Valley 11 units and the San Francisco well water 35 units. In each case, soap has been added until the corresponding suds rise to the same height and become permanent.

In the addition of soap to these waters they have been softened. The proof that they are now soft is in the fact that the suds remain fixed. The suds will disappear unless all the hardening salts are destroyed. If we were to take one thousand gallons of water from

each of the three supplies from Fresno, San Francisco and the San Francisco well water, the cost of softening with pure soap, soap costing 10 cents per pound, would be respectively $1.20, $1.50, $5.10. To actually soften the water by a removal of the hardening salts by present day methods would be $.02, $.026, or $.085, cents per thousand gallons respectively or one-sixtieth as much as by using soap and many times more satisfactory.

When a utility, whether privately owned, mutual or municipal in nature, takes up anything that is new or in any way savors of an innovation it must do so from a somewhat different angle of approach than that of an owner of an industrial plant. An individual has no one to whom he must answer or give an accounting. He makes his own investigation in his own way and if his findings lead him to believe that the investment of funds for any particular purpose will assist him in his business, he makes the necessary expenditures and takes the consequences. If his study was wisely made, he will either simplify the methods of production, reduce labor cost or produce a finer grade of finished product according to what the particular object of the investment was. He is at least the winner or loser. But with the public utility, it is not so simple. Every utility corporation has as many critics as it has consumers and it must answer to them in some way, through city councils, utility commissions or some other rate fixing board. Take the problem of supplying a soft water. There are very few cities so favorably situated that a natural soft water supply is available. Under these conditions there is only one alternative and that is actually to soften the existing supply. To do this requires additional capital investment and additional operating expense. This additional cost for water must be borne by the consumer and the additional rate to the utility must be granted by the rate fixing board. The utility corporation must therefore educate the consumers to the value of soft water in advance if it is to take the lead in its special line of service. This educational work is necessary because the general public does not understand the value of soft water. Very few people have ever experienced soft water in the home and have therefore no real unit of measurement by which to determine the value. They are, in the masses, unconscious of the load they are carrying in their daily battles with sticky curds, clogged pipes and heating systems that will not heat. To these troubles they have become to a large extent immune because they are considered unavoidable and they have unconsciously resigned themselves

to the conditions. Such conditions are unnecessary but exist in most city supplies. In this day when every man is a specialist, it is only fair to consider that the utility corporation is a highly organized specialist always alert to give the best possible service within its power for which the public will pay. By its specialization in service it should give to the public the service in advance of public demands. It should always be just ahead of public demands and never behind. It must be the educator and teach its consumers the value of the service to be rendered so that if an additional rate must be obtained it will be understood and granted.

In the case of soft water the consumers would of necessity have to pay more per thousand gallons for the water, but they in turn would be financially benefited because of savings made in other ways. Consider for instance the benefits to be derived in the average home. To soften water with soap requires per thousand gallons of water $1\frac{1}{4}$ pounds of soap per grain of hardness, or on a water like that furnished by the Spring Valley Water Company, 15 pounds of soap, which at a cost of 10 cents per pound would be $1.50. If the water were softened before delivery it would entail an extra cost to the consumer of probably five cents per thousand gallons. This would mean that if one-thirtieth of the water used in the home were used with soap then the consumer living in San Francisco could afford to pay five cents more per 1000 gallons for his water without increasing his monthly expenditures. The benefit that he would derive, however, from saving in soap would be the smallest of the benefits that would accrue from the advantages thus obtained. In the home, first of all, would come the real luxury of the use of soft water. This would appear in the reduced labor of house work, for with soft water a sticky curd or high water mark on the bath-tub is unknown. The same is true of the wash basin or the kitchen dishpan. Clothes washed in soft water have an increased life of from twenty-five to one hundred per cent. Not long ago I learned of two laundries that ran tests of the life of collars washed in hard and soft water. In the laundry using soft water, the collars lasted nearly twice as long as they did in the one using hard water. Then too there are the advantages of reduced cost in plumbing. With soft water no scale is deposited in hot water pipes. This means long life to waterbacks and copper coils in heaters, fewer plumbing bills as well as reduced cost in fuel consumption due to better heating conditions. It would appear therefore that the advantages accruing to the home in reduced

costs are many times that of the saving in soap and many times that of the additional cost of the soft water.

In industrial lines the savings are equally as large as in the home and much more readily measured. Take for example a hotel. A hotel of 500 rooms has a linen bill annually of $30,000.00. Soft water versus hard water will increase the life of linens at least one-third, a very tangible asset for the hotel company. A similar advantage is obtained in the operation of boilers, for without scale but little cleaning is required, and fuel consumption correspondingly reduced. It is not improbable that of all the fuel burned in San Francisco today for heating purposes and the generating of steam five per cent could be saved if the water used were free from scale forming salts. The hardening salts in water and scale forming salts are synonymous. In San Francisco each month there is burned approximately 240,000 barrels of fuel oil. If oil is worth $1.20 per barrel and 5 per cent could be saved, then there would be an annual saving of about one quarter of a million dollars on fuel alone. Add to this the reduced cost of boiler cleaning and the increased life of boiler tubes and boilers and you will obtain an amount great enough to pay for the cost of softening all the water of the city for a year. In one small boiler plant in San Francisco carrying an average load of 400 horsepower the owner reduced his operating costs about $3000.00 annually by a change from hard to soft water. This amount was made up almost entirely from saving in boiler cleaning. The saving in oil was largely intangible due to the nature of the load carried and the lack of records. In Oakland an industrial plant wiped out a ten thousand dollar investment in six months of operation due to increased production and better quality goods made possible by soft water. Another company in San Francisco was threatened by their insurance brokers with entire shut down on account of a badly scaled boiler and they had no standby boiler to alternate to during repairs. A soft water plant was installed, the scale removed by dissolving of scale in the soft water and the threatened shut down avoided. These are scattering examples only, but it takes but little imagination to picture the industrial advantage one city with soft water would have as compared to another equally well located but supplied with a hard water.

The beneficial results that would be obtained by softening a city water supply would vary according to the nature of the city, whether industrial or residential. The degree of hardness of the raw water would have little to do with the installation of the system when con-

sidered from an economical standpoint, considered in terms of an investment because hardness in water is detrimental and obnoxious in proportion to the amount present. If hardness in water is a disadvantage then its absence is equally an advantage. If hardness is present in the water supply then the benefits derived by its removal are in direct proportion to the amount removed. If it is an advantage to eradicate five grains of hardness in a water supply carrying ten grains, then it is twice as advantageous to eradicate ten grains. In other words if there is hardness in the water supply and it is worth while eliminating any part of it, it is equally and proportionately advantageous and worthwhile to eliminate it all.

The process of softening should be that method best adapted for removing all the hardness from the water with the least expense. No arbitrary rule can be laid down that will fit all conditions. Each case is a special problem and must be so treated.

Although municipal supplies have not been softened here in the West, the individual industries in many instances have not overlooked the opportunities and advantages to be derived by softening their own supplies. As an example of this I will cite the city of San Francisco where the total average daily water consumption is about 46,000,000 gallons. Of this amount 8,000,000 gallons is pumped from wells and 38,000,000 gallons supplied by the Spring Valley Water Company. There are privately owned water softeners in operation today softening 8 per cent of the total amount of water used in San Francisco, having a combined softening capacity capable of softening fifteen per cent of the total amount of water delivered by the Spring Valley Water Company and the rate at which the softeners are being installed is continually increasing. They are being installed for all lines of industries and there are today thousands installed in private homes in the State of California. As rapidly as the public really learns of the possibilities and advantages of water softening installation, they are being installed. What is true of the city of San Francisco in respect to the per cent of consumed water being softened is more or less true of every city in the State having a population of 10,000 or over.

The cost of the privately owned water softeners in the City of San Francisco today is greater than would be the cost of a centralized station installed and operated by the Water Company to soften every drop of water delivered by that Company through its mains. It is interesting to note here the extent to which an individual will go to

obtain soft water for his home. The initial cost of installation of a household softener is 150 times as great as it would be to obtain the same amount of capacity through a large centralized station. You will realize what this means when you recall that of the water sold through your systems over half is for household and commercial uses other than direct industrial and municipal consumption.

A public utility corporation, being monopolistic in nature, has a duty to serve. It is its duty to serve to the utmost and give the maximum of beneficial service for which the public will pay. If, by removing the hardening salts from the water delivered to the consumers, it is thereby rendering a service, the value of which is greater than the additional necessary charge for the service rendered, then the water should be softened. In view of the rapid advancement that has been made in methods of water softening in very recent years, the present cost of softening water and the enormous resultant savings effected in all lines of industry and in the home by the use of soft water, it is not improbable that the time has arrived when every water company should seriously and actively take up the question of softening its supply. It should anticipate the needs of its consumers and give that service which by its position can be done on a wholesale basis so much better and cheaper than the same results can be obtained individually. This applies to all companies that are not now serving absolute soft water. Remember that a hard water is objectionable in porportion to the hardening salts present. Likewise the benefit derived from softening the supply is in proportion to the hardness removed. The initial cost of the softener is nearly proportional to the amount of hardening salts to be removed and the actual cost of softening the water is directly proportional. Under these conditions, it is easily forseen that water companies in the future will soften as well as purify municipal supplies with benefits to both the public and themselves.

COMPOSITION OF ALUM FLOC IN MIXING BASIN

By Edward S. Hopkins[1]

Last year Miller (1) published a study of the composition of floc from alum solutions. This paper presented certain fundamental facts of importance to the study of mixing basin floc. Showing the applicability of these principles to plant operation will be the object of this paper.

Baylis (2) found when using Gunpowder River water that a liter sample required fifteen minutes stirring at 100 revolutions per minute with mechanical agitator, after addition of the coagulant, to produce a floc which duplicated that obtained from the effluent of the plant mixing basin. Therefore, floc obtained from agitation in this manner can be considered equivalent to that produced under plant conditions.

This study covers pH values from 4.0 to 9.8 and alum concentrations of 1, 5, 10, 25 and 50 grains per gallon.

METHOD OF TEST

Samples of river water (turbidity not exceeding 15 parts per million) were treated with a given dose of alum in liter beakers, rapidly mixed by stirring with a rod and then agitated with mechanical stirrer as noted. pH value was determined upon completion of agitation and sample allowed to settle for thirty minutes. The precipitate was washed by centrifuging and subsequent decantation with hot water until free of sulfates, care being taken to break up the floc at each washing.

When necessary, either sulfuric acid or sodium hydroxide was added to the water to produce a given pH value.

Determinations were usually made for every 0.5 pH value.

RESULTS.

It was not possible to produce good floc below pH 4.5 (for 1 grain per gallon alum—pH. 5.2).

[1] Sanitary Chemist, Water Department, Baltimore, Md.

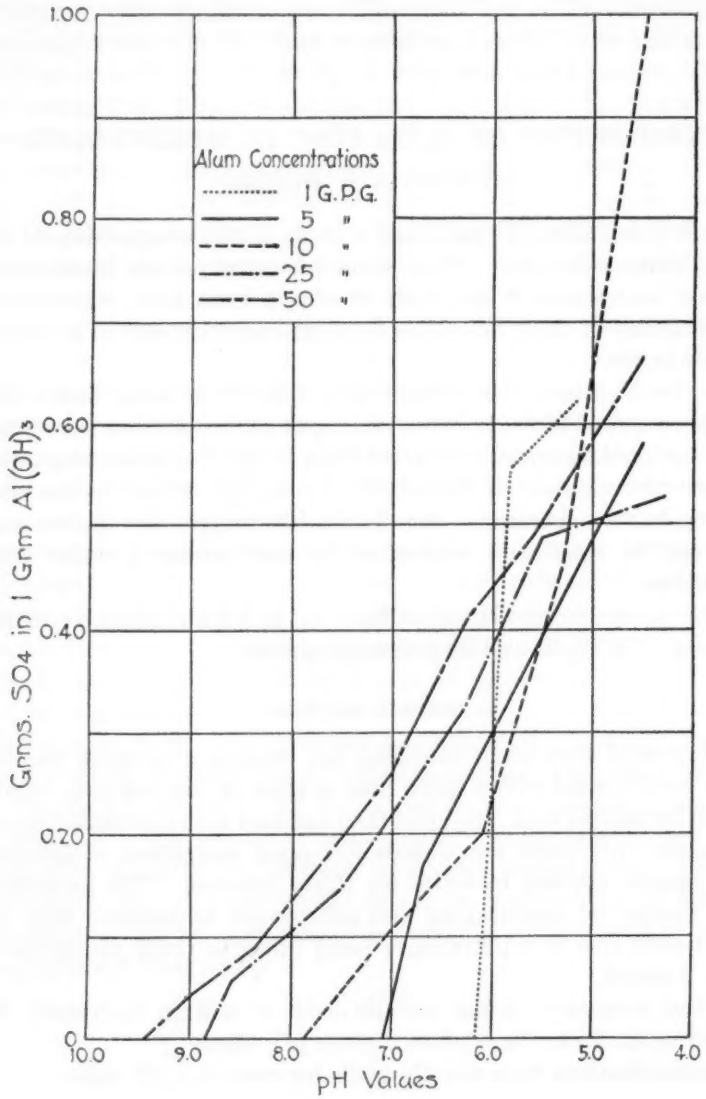

FIG. 1

Figure 1 presents the amount of sulfate found in floc at varying pH values with a given alum dosage. It is clearly shown that as the pH value decreases the amount of sulfate present increases. Deter-

mining the pH value of a settled water and referring to the curve will show whether sulfates are present or absent in the floc.

Assuming pH 6.5 to exist in the average mixing basin. Sulfates are absent using 1 grain per gallon alum, but increase in small quanity with greater concentrations.

Miller plotted his sulfate values in the mol ratio of $\frac{Al}{SO_4}$. This gives a number which increases as the sulfate content decreases. Figure 2 expresses results in a similar fashion. The ratio of Al to SO_4 is almost constant between pH 4 5 and 5.5 and at higher pH

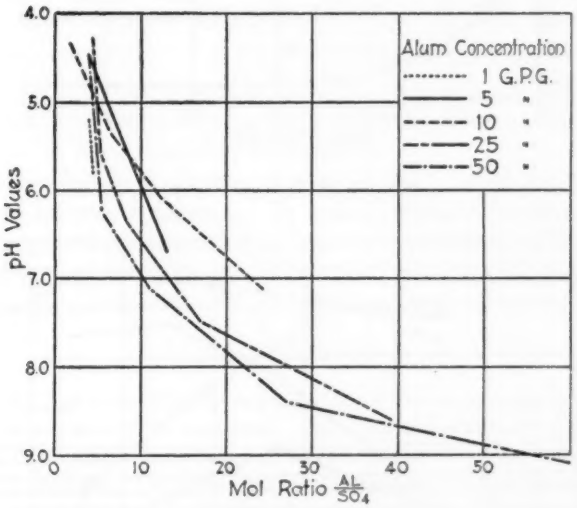

FIG. 2

values rapidly becomes greater and eventually increases to infinity, which compares very favorably with Miller's curve. It is noted that the sulfate decreases more rapidly in the dilute solutions and disappears at a lower pH value.

Plotting the mol ratio of $\frac{Al}{SO_4}$ against the mols of NaOH per mol of Al added to produce the floc (fig. 3), it is found that the points are reasonably correlated. In computing the amount of alkali added the alkalinity of the water was calculated to NaOH thus giving equal value for all alkali present.

It is shown that, when less than three mols of Na OH are added per mol of Al, the precipitate remains practically constant in com-

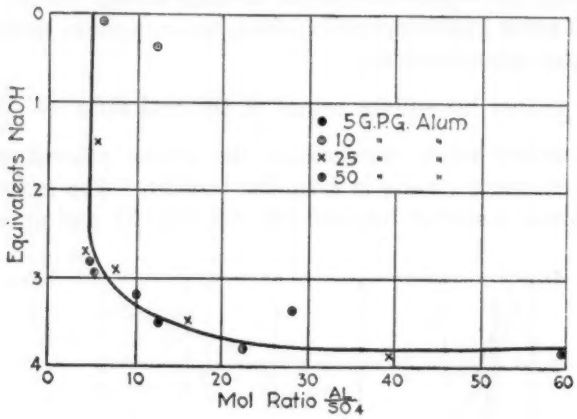

FIG. 3

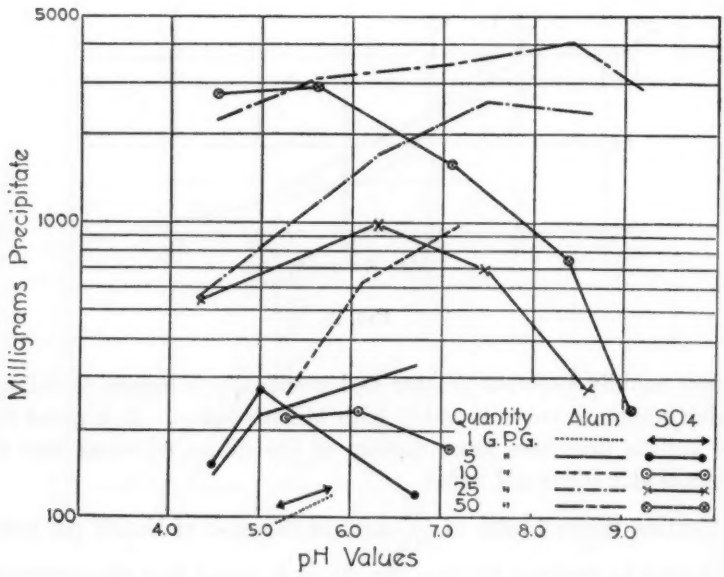

FIG. 4

position and approximates the formula $5(Al_2O_3)\ 3SO_3$ as stated by Williamson (3) to exist. The applicability of this formula to the

floc was proved by actual determinations, pH values from 4.5 to 6.0, at all concentrations of alum, giving results in absolute agreement.

Upon addition of more than 3 mols of alkali the proportion of sulfate decreases and it is finally possible to wash the precipitate free of it. In general agreement with Miller this would indicate for dilute solutions, that when a quantity of sodium hydroxide in *excess* of that required to react with the aluminum ion according to the equation $Al \div 3\ OH = Al(OH)_3$ is present, the precipitate can be washed free of sulfate.

It is not possible to advance the hypothesis that sulfate absorption is due to mechanical attraction by the precipitate. If this were true, the quantity of sulfate present would increase with corresponding increase of precipitate. Curves shown in figure 4 prove this hypothesis unfounded, for as the quantity of floc at a given alum concentration increases the amount of sulfate decreases, equal volumes of the same solution being used for the analysis.

This study has been presented to prove that floc precipitated from the dilute solutions necessary in water purification processes and under stimulated plant conditions has the same chemical composition as stated by Miller (1) to be true for that precipitated from concentrated solutions.

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DISCUSSION OF REPORT OF COMMITTEE NO. 6 ON INDUSTRIAL WASTES IN RELATION TO WATER SUPPLY[1]

MR. W. L. STEVENSON: The Sanitary Water Board of the Commonwealth of Pennsylvania, referred to in the excellent report of Committee No. 6, organized for the transaction of official business on July 17, 1923, and has to date held twenty-one meetings, approximately twice a month. The problem of utilization and conservation of the natural water resources of the State of Pennsylvania confronting the Board is stupendous.

A large proportion of the citizens of the State dwell in incorporated municipalities provided with public sewer systems. Pennsylvania is one of the greatest industrial States in the Union. The development of natural resources such as coal and oil and the many kinds of industry all constitute actual or potential sources of stream pollutions. It is, therefore, apparent that the major problem demanding a solution is the conservation of the streams as sources of public water supply, for fishing and recreational use and also the utilization of the streams for inoffensive and harmless disposal of polluting materials by dilution.

The fundamental resolution of the Board for classifying streams is the proposed solution of this problem. Fish wardens of the Board of Fish Commissioners, Forest Rangers of the Department of Forests and Waters and Health Officers of the Department of Health in the performance of their normal field duties are traversing the now unpolluted tributary streams and certifying on maps prepared for that purpose those streams which they find to be unpolluted from any artificial source. This work is being chiefly done in the northern and southern tiers of counties and in the eastern part of the State because in those localities are to be found most of the now clean streams.

After reports are made, the Sanitary Water Board by appropriate action designates such streams as Class A. Since the meeting on

[1] Presented before the New York Convention, May 22, 1924. See Journal, May, 1924, page 628.

February 12, 1924, the Board has designated as Class A about 3500 miles of streams in Pennsylvania among the following counties: Bedford, 595 miles; Cameron, 225 miles; Franklin, 1000 miles; Fulton, 560 miles; Monroe, 700 miles; Pike, 380 miles; total 3460 miles.

Field surveys and examination of office records are under way by the engineers of the Department of Health for the purpose of making report to the Board for designation of streams draining inhabited watersheds as Class B and Class C.

Reasonably clean water is essential to processes of manufacture in many industries and there are industrial wastes causing stream pollution which may contain by-products of value. If through research, ways and means could be found to remove such constituents it would not only be a benefit to such industries, but simultaneously would cause abatement of the stream pollutions. To that end the Sanitary Water Board has already had and proposes to have further conferences with representatives of industries to attain coöperative and mutually beneficial results.

A recent opinion of the Attorney General to the Secretary of Health is of interest to waterworks managers, namely: that the Sanitary Water Board has jurisdiction over the discharge of wastes containing taste and odor producing constituents such as phenol, gas house wastes, etc., provided that such substances do or are capable of producing sufficient tastes and odors in a public water supply derived from the stream into which the wastes are discharged, that the public using such public water supply refrain from drinking a substantial quantity of water or resort to the use of apparently attractive water from private sources but which may be contaminated and thus in either case menacing the health of the public.

Mr. J. W. Ellms: The situation in Cleveland has been one of considerable interest and difficulty. A very foul taste in the water supply has been noticed for a number of years. It was doubtful for a long time as to where and what was the cause of these intermittent tastes, which came generally in the fall or winter months or with the breaking up of the ice in the lake. In 1920 we undertook an investigation to find out the source of the taste-producing substance or substances, and by a series of eliminations and the collection of some 1100 or 1200 samples, we succeeded in locating the source of the trouble. These we traced to three by-product coke oven plants. These three by-product coke oven plants are located on the Cuyahoga

River. They were discharging their wastes into the Cuyahoga River. The wastes containing phenol came from the ammonia stills, from the benzol plants, and from the coke quenching process. It was very difficult to determine where the sewage went, but, by the analytical work we did, we were able to do so. We brought these manufacturers into a conference with the Health Department officials and laid this report before them and they admitted that they were the people who were causing the trouble. We then asked them to cease doing this, and we tried to make it plain to them that the nuisance which they were creating was something that could not continue and asked them to find remedies for it. Nothing was done for a year or two. The State Health Department supported us in our plans. There were opinions of the Attorney General's pro and con as to whether it was a real health menace or not, but, finally, with some officials of more backbone than others, we succeeded in bringing these manufacturers to a sense of their duty in the matter and they have put in operation a system by which these wastes are taken out of the Cuyahoga River. One concern has spent about $300,000 in changing its plant. Two other concerns have spent over $100,000 in addition; something approaching a half a million dollars has been expended to keep these wastes out of the supply. We hope that these are the principal sources. There may be some other sources, but it is the intention of the city to conduct another survey in order to determine whether this is the case or not.

With respect to phenol wastes, it is certain, as far as we know and from the investigations we have made, that they must not be permitted to enter a water supply, for once they get into the supply there are no known processes, at least that I know of at the present time, by which we may remove phenol. If chlorine is used as a disinfectant, the combination of the two certainly produces the foulest tasting water you can imagine;.

MR. H. R. CROHURST: In regard to the phenol waste problem the Public Health Service has been coöperating with the State Boards of Health in an endeavor to work out a satisfactory solution of the problem.

On January 29, 1924, the Surgeon General of the Public Health Service called a conference at Washington of the State health organizations to discuss the extent of the phenol problem, to obtain ideas as to the necessity of federal legislation at the present time to assist in

the elimination of this waste and to go over in general all phases of the problem.

As a result of the Washington conference it was the concensus of opinion that drastic legislation at the present time would not aid materially in the solution of the problem, that the majority of the individual states already had sufficient legislation to prevent stream contamination if recourse to the courts was necessary and that first some plan of coöperation with the manufacturers should be attempted.

Since a large majority of the by-product coke plants are located on the Ohio river watershed, an organization of the Health departments of the states on the Ohio river drainage area was formed with Dr. John E. Monger, Director of Health, Ohio, as chairman and E. S. Tisdale, Director of Sanitary Engineering, West Virginia, as secretary.

At the request of the chairman of this organization the Public Health Service gathered information as to the number and ocation of phenol waste producing plants on the Ohio river watershed and the number of water works plants that have had or now are having trouble from taste and odors due to phenol contaminated water.

Briefly, the survey showed that there were 19 phenol waste producing plants on the watershed, the majority being located in Pennsylvania, Ohio and West Virginia; that approximately 27 water works plants have reported trouble due to tastes and odors from the combination of phenol and chlorine used for disinfection and that there are 24 other communities using treated surface supplies in conjunction with chlorine that have not as yet reported trouble, but which are located below phenol waste producing plants and may at some future time be subject to these disagreeable tastes and odors.

MR. E. S. TISDALE: The "Phenol Wastes Conference of States on the Ohio River Watershed" was held at Pittsburgh, April 14, 1924.

There were in attendance between 40 and 50 delegates. The States of Ohio, West Virginia, Pennsylvania and New York were represented by the Health Commissioners and Chief Engineers of the State Health Departments. The United States Public Health Service sent both medical and sanitary engineering personnel and several consulting engineers interested in phenol wastes disposal also attended the conference. The by-product coke industry representatives who were there by invitation numbered about forty. The purpose of meeting jointly in this manner was to gather evidence

as to the experience of the coke industry in handling phenol wastes. Also it was hoped that machinery might be set in motion for amicably solving the question of disposing of the objectionable taste-producing industrial wastes which are now damaging public water supplies and thereby injuring public health.

The United States Public Health Service, following a careful study by a well qualified sanitary engineer, presented a report showing the distribution of phenol wastes-producing plants on the Ohio River watershed and communities reporting tastes and odors in their public water supplies. The report was complete with tables and maps and showed clearly the magnitude of the problem. This was presented at the start of the conference.

The chairman of the conference, Dr. J. E. Monger, Director of Health, Ohio State Department of Health, called upon each coke or steel company represented to give a recital of their method of handling the objectionable taste-producing wastes. One of the most interesting points brought out was the fact that many of the larger steel companies producing phenol in the manufacturing processes are now keeping 100 per cent of the phenol wastes out of the stream or are building treatment works to accomplish this object. All the testimony given orally was recorded by the stenographic secretary and it is to be available for all the delegates to the conference as soon as the report has been prepared.

The coke company representatives brought out the fact that the method of evaporation of the wastes by quenching the coke, which appears to be the only practicable process so far developed, is expensive and they welcome any efforts to reach a less expensive and yet satisfactory method of disposal.

The Conference of States offered to the manufacturers present an opportunity to join the conference and effect an organization which could jointly work toward a solution of the phenol wastes problem. A resolution was passed to the effect that the United States Bureau of Mines be requested to conduct research experiments on the phenol wastes problem with a view to getting a cheaper method of wastes disposal. The United States Public Health Service definitely promised research work on phenol wastes studies in the field of public health. These can readily be carried on now at the new experimental plant recently completed by the United States Public Health Service at Cincinnati, Ohio.

The conference accomplished a step forward in the solution of this perplexing trade wastes problem in that all the evidence regarding treatment methods and magnitude of the problem was gathered both from states and manufacturers. It is the intention of this Conference of States on the Ohio River watershed to adopt some definite policy for the control of taste producing wastes which damage public water supplies, which policy can be adopted and enforced by all states alike.

MR C. A. EMERSON: There is not much to be added to the brief statement in the report. The City of McKeesport, Pa., for several years suffered periodic pollutions of its supply due to the waste from byproduct coke ovens. The fault was clear; the Steel Company admitted the fault but there seemed to be no legal remedy available in the state to handle the matter. The City asked for a temporary injunction which the court granted after argument. At the time of the granting of this injunction, the Steel Company had under way remedial measures, but the fact remains that there is an injunction on record which was secured by the City where there was apparently no State law which applied directly. Since this injunction has been in effect, the City of McKeesport has been able to operate its water works with practically no interference from these coke oven wastes. The plant is situated above the City about eight miles. It is several times larger than any other coke oven installation in that country.

MR. A. L FALES: The so-called "Oil Pollution Act, 1924" became law on June 7, 1924. This Act provides that except in certain cases of accident or emergency, or as permitted by regulations which the Secretary of War is authorized to prescribe, it shall be unlawful to discharge oil into or upon the coastal, navigable waters of the United States from any oil-burning or oil-transporting vessel.

The penalty for violation of this Act is a fine not exceeding $2500 nor less than $500, or by imprisonment not exceeding one year nor less than thirty days, or by both such fine and imprisonment, for each offense. Clearance of such vessel from a port of the United States may be withheld until the penalty is paid, and said penalty shall constitute a lien on the vessel. Provision is also made for revoking the license of the officer of the vessel.

For the administration of the Act, the Secretary of War is authorized to make use of the organization, equipment and agencies employed in the improvement of rivers and harbors, and the officers and agents in charge of such improvements, and the assistant engineers and inspectors employed by them; and the officers of the Customs and Coast Guard Service are charged with the arrest of violators of the provision of the Act.

The Act also provides as follows:

> SEC. 9. That the Secretary is authorized and directed to make such investigation as may be necessary to ascertain what polluting substances are being deposited into the navigable waters of the United States, or into non-navigable waters connecting with navigable waters, to such an extent as to endanger or interfere with navigation or commerce upon such navigable waters or the fisheries therein; and with a view to ascertaining the sources of such pollutions and by what means they are deposited: and the Secretary shall report the results of his investigation to the Congress not later than two years after the passage of this Act, together with such recommendations for remedial legislation as he deems advisable.

For this investigation, the sum of $50,000 is authorized in addition to funds already appropriated for examinations, surveys and contingencies of rivers and harbors, which may be drawn upon.

This Act is "Public—No. 238—68th Congress (S. 1942)," and copies may be obtained from members of Congress.

THE ACTION OF WATER ON SERVICE PIPE[1]

DISCUSSION

MR. J. M. DIVEN: As Mr. Donaldson well said, this committee has been very lax. The Committee thought that one of the easiest things it had to determine was what degree of hardness was necessary in water to make the use of lead pipe safe. As you have just heard, we got into very deep water. Our desire and intention is to try to standardize services; that is, to find a material for services that will meet, as nearly as possible, all the conditions, cost, durability and consideration for health. This may be very difficult, but we hope that we are going to come very near to it. It would be all very nice if every water works—Mr. Donaldson said there were some 6500, I think, in the United States and Canada—would have their water analyzed and determine for themselves just what material they required for services, but they will not do that. It is up to us to try to find some standard material that will meet almost all conditions. It will probably fail in some of them. A very large number of cities, by city ordinance, require the use of lead pipe.

Lead pipe is satisfactory from a mechanical standpoint; the cost is not excessive, and in almost all cases the life is very long, almost indefinite. But, if we are endangering health by the use of lead pipe, certainly we must find something to take its place. Galvanized iron is used extensively recently; I think galvanized steel more extensively. In first cost, this is probably the cheapest material we find, but its life is very uncertain, especially with steel pipe it is rather short in a great many cases. Personally I know of galvanized iron services, the old galvanized iron we used to get about the time this Association was formed, that I put in myself over forty years ago, and it seems to be still serviceable, but I doubt if we are getting the quality of galvanized iron and galvanizing that we got at that time.

Two unfortunate circumstances prevented your committee sending out a questionnaire to get some idea of the cost of different

[1] Discussion before the New York Convention, May 23, 1924. See Journal, May, 1924, page 649.

characters of pipe. The unfortunate condition this year was my rather sudden change in business, and perhaps more important, one might have eliminated the other, the lack of funds in the particular account to take care of it. However, we will try to do it. You all know I have a little money, and if the Association has not the funds the questionnaire will go out anyhow.

The use of small size cast iron is comparatively recent. I found at Troy cast iron service pipes that were put in from fifty to eighty years ago. They are being taken out now very rapidly and on streets that are going to be permanently paved, the cast iron services are all taken out. They are badly corroded and stoppered up so that you can take a piece a foot long and hold it up to the light and can hardly see light through it. How any water ever crawled through it is a mystery. This, however, is uncoated pipe. I think this is about all that your committee can report on now, except that we will try to be a little more vigorous during the coming year. The subject will be divided into two questions, the sanitary and the mechanical. When the mechanical data are secured, we will have to turn them over to the chemists and bacteriologists to find whether the pipe that seems, from the mechanical standpoint, the best, will stand the health test; and I assure you that the committee will try to do something this year and bring in a satisfactory report.

MR. WM. F. WILCOX: Did you take any particular precautions when you put in those services that lasted so long?

MR. DIVEN: No, nothing except buying such galvanized iron as was in the market at the time.

MR. WILCOX: I mean the ones that lasted forty to fifty years.

MR. DIVEN: Those were the ones that did not last; I am only going back forty years; if you really want the truth, it is fifty years last November.

MR. WILCOX: I do not want to embarrass you.

MR. DIVEN: You will not embarrass me; there are different ages in life; the little child will always try to appear older; when a lady gets past twenty-one, she wants to appear eighteen, but finally we get to a period in life when we are proud of our age.

MR. F. N. SPELLER: In a survey of the information on service experience such as Mr. Donaldson has compiled, it has naturally been impossible to go into very much detail in some particulars, I just want to call attention to a few points, at his kind invitation, with reference to iron and steel services. Under his heading of the "accepted facts" regarding corrosion, there are two that I would take issue on. In the first place, he states that carbonic acid is the prime factor in corrosion. The work done by Dr. W. H. Walker, whom he cites, at the Massachusetts Institute of Technology and by others, indicates beyond any doubt that in ordinary water the oxygen concentration is the most important factor, and as a matter of fact it has been shown recently by a number of experimenters, that, with natural water with a pH of between 5.5 and 9.4, the acidity due to the CO_2 content is not important excepting so far as it affects the scale forming properties of the water. I would cite, as experimental evidence on that, the fact that water, which had been deaerated by the deactivating process, is practically non-corrosive, and at the same time in removing the oxygen the CO_2 content has not been changed. There are over a hundred of these apparatuses in use in this country now, and that effect has been very noticeable.

The second "accepted fact" that I would take very strong issue with is that galvanized steel is essentially less durable than galvanized wrought iron when in contact with water. Dr. Walker, the authority whom Mr. Donaldson cites, made a very extensive survey of iron and steel services in New England several years ago, as referred to in the paper Mr. Donaldson has just read. He found, not only by laboratory experiment, but by actually locating in the field services that contained both iron and steel in the same line, that there was no noticeable difference in the long run, between these two kinds of pipe. Sometimes one was a little better than the other and sometimes it was the reverse. In that connection, other engineers have made extensive experiments in water lines, particularly in hot water, with the iron and steel in the same lines, and have not found the difference that Mr. Donaldson states. As a matter of fact, I do not think statements like that should be made any longer without experimental evidence. There is too much definite evidence from long experience which shows that the difference, if any, is very small. Now if you will permit me, I will run over briefly what seem to me to be the established facts regarding corrosion.

In the first place, both water and air must be present together, and when corrosion occurs, it is proportional to the oxygen concentration within the pH limits referred to above.

The second most important fact is that protective films on the metallic surface retard corrosion more or less; sometimes this becomes the controlling factor even more so than the oxygen concentration. There is a close connection between this fact and the pH value as referred to above.

Third, the contact effect between dissimilar materials, brass and iron, for instance; differences in concentration of ground water, or water in estuaries where sea water occasionally lies in contact with fresh water, causes accelerated action on the metal exposed to the more dilute solution. This has been found to be a very important factor in certain cases of soil corrosion.

Velocity and temperature both accelerate corrosion, as evidenced by the action of turbulent flow.

Composition has very little effect on corrosion in water, and probably underground, although we do not know so much about soil corrosion as corrosion in water and air, but there is no question that a large range of variation in composition may exist without being a controlling factor. The American Society for Testing Materials have been conducting for several years a series of tests on about twenty-five different kinds of ferrous metals immersed in various kinds of water and exposed to the atmosphere, including a range of composition from ingot iron (so-called), which is supposed to be 99.8 per cent pure iron, up to wrought iron which carries 2.5 to 3 per cent cinder and other impurities. No noticeable difference whatever has been found between these in the tests in water.

Other factors, such as the salt content of the water, over-voltage of the metal, humidity of air, and many other points are important, but the ones mentioned I think are most important. The various factors affecting corrosion in water bear a different relation to each other in alkaline, neutral, and acid water as pointed out by Mr. R. E. Wilson in a paper on the "Mechanism of Corrosion" (Journal Ind. and Eng. Chem., 15, 126, 1923). (See also "Effect of Hydrogen-ion Concentration on the Submerged Corrosion of Steel," Journal Ind. and Eng. Chem., 16, 7, 665, 1924.) The point is that there are several factors that are of importance in governing corrosion, and they have a very different relation to one another according to the pH value of the water, so that any tests made must take into account not only all

these factors, but must also have those factors present in about the same relation to each other, or it is evident that one will get very different results. This explains the difference of opinion that often exists from experience in different places. One man will be dealing with water that has a very high protective film-forming power. Another will be experimenting with neutral water where the oxygen concentration is the prime factor.

Copper in steel aids in the formation of protective film in air and, therefore, this metal lasts three or four times as long as ordinary steel without the copper. This is not the case under water, which again illustrates the fact that composition is important in atmospheric corrosion, but of very little importance in under-water corrosion.

A MEMBER: How do you relate temperature and velocity as an element?

MR. SPELLER: They are related in a way because they both have to do with accelerating all chemical reactions, and velocity helps to aid the diffusion of oxygen.

A MEMBER: Velocity is the rapidity of chemical action rather than the flow in the pipe.

MR. SPELLER: Velocity increases the rate of diffusion of oxygen to the surface of the metal; it helps to mix the water up; in this way these factors are very closely related. I like to look at the mechanism of the corrosion probem as analogous to the flow of water through a pipe. If the pipe is smooth and there are no obstructions of any kind, the water will flow at a certain rate, but if you have valves or other obstructions in the line, you have something analogous to the influence of polarization, film protection, a counter e.m.f., over voltage and the other factors that tend to retard the solution of the iron and congest the whole process. If there were no natural tendencies to stop corrosion, the damage would be very much more than we can imagine, because the solution pressure of iron in water is enormous, but fortunately we have certain natural tendencies which may be artificially controlled to a large extent. Considering the number of variables involved you can see how important it is to be careful in drawing conclusions from experience in one field of

corrosion and applying it to other fields where a different set of factors apply.

MR. R. S. WESTON: In the beginning I wish to compliment the Committee upon the excellence of its report. In its discussion I should like to emphasize the importance of oxygen in corrosion.

A very good example of the corrosive effect of oxygen is found in our town of Brookline. Formerly the supply came directly from wells and contained 32 p.p.m. of carbon-dioxide, 1.5 p.p.m. of oxygen, 0.67 p.p.m. iron and 0.2 p.p.m. of manganese. In 1914–15 a deferrization plant was built which produces an effluent containing less than 6 p.p.m. of carbon-dioxide, 0.007,p.p.m. of iron, no manganese and practically saturated with oxygen.

Prior to deferrization there was a deposit of iron and manganese on the insides of the pipes which protected them to some degree, while the services were cement lined. Consequently there was little observable corrosive action before the little action on services since. On the other hand the house plumbing was not protected and since the water has been oxygenated has suffered greatly. Tin-lined brass resists the action of even hot water, as does copper, when it is provided with insulating couplings, but the best iron or steel is short lived even when insulated against electric currents. Especially liable to attack are the horizontal hot-water pipes. Where the copper pipes are not insulated even this metal dissolves.

At Milford, Mass., where we have been observing the action of water on lead services for many years we find that a dose of about 10 parts of lime per million reduces the lead content in water drawn from a test service pipe to an average 0.085 p.p.m. and where the water is allowed to stand over night to a average of 0.27 p.p.m. Formerly the water might contain 3.0 p.p.m. of lead under conditions of ordinary use and lead poisoning was frequent.

This treatment is successful with waters having hardnesses of more than 30 p.p.m. With waters having hardnesses of less than 20 p.p.m. and derived from colored surface sources the efficacy of lime treatment is doubtful. However, our experiments show that in such cases small doses of sodium silicate afford equal or better protection than that secured by lime treatment.

We have made tests at Milford to determine the pH value of the water which had the least action on lead and so far these point to a value of 7.6 which is rather lower than the pH value of the solution

of calcium carbonate which would have the least solvent action on lead, namely pH = 8. Why this alkalinity may be lowered to correspond to a pH value of 7.6 in practice is probably because there are other protective substances present, besides calcium carbonate.

As to the permissible amount of lead in water: Here it is true that we are revising our limits downward and such sanitary engineers as Mr. Howard of the New Hampshire Board of Health protest the presence of any lead at all, while we have under observation for one of our clients a case of lead poisoning where water containing less than 0.1 p.p.m. of lead is apparently injuring the health of one individual in a large community.

Of course, there is a great deal of variation in susceptibility to lead poisoning just as there is to alcohol or any other poisoning. Some can stand a lot, others hardly any.

The most generally applicable remedy for lead poisoning is to use cement lined services. In the second technical paper I ever wrote, which was over twenty-five years ago, I advocated these services. I still do and I am glad to see the day when improved pipe of this type may be purchased of the maker and shipped by truck or rail to the user.

A new possibility is the use of small cement-coated, cast-iron pipe in place of cement-lined, wrought iron.

Wooden pipe must not be forgotten and where it is permissible for structural reasons obviates all corrosion troubles.

In all studies of corrosion by water it must be remembered that pure water has practically no action on metals. It is the foreign substances,—like oxygen, carbon-dioxide, calcium, "hardness" and alkalies, —which make the water corrosive or non-corrosive and consequently the determination of its properties by analysis and experiment is a necessary preliminary to the choice of a material for service pipes.

MR. DAVID A. HEFFERNAN: Mr. Donaldson has given much time in the preparation of his most interesting and instructive paper and there is no question in my mind but that what he has said will be of benefit to his listeners.

He is right when he says "there is no one-best pipe" applicable to all conditions. Economy of installation and maintenance are paramount issues in service installation. But there are times when a saving in the cost of installation is permitted to overshadow the

postponed cost of maintenance. The ideal material for delivery of water from main to meter is the one which will give the greatest length of service at the least expense of installation and repair.

The cost of the pipe is the smallest contributing factor outside of the fittings. The cost of excavation, back-filling and replacement of pavement is from 40 to 70 per cent of the entire cost, varying of course with the soil material, kind and grade of pipe, etc. Some waters have affinity for pipes of certain materials and these may be easily determined and avoided. It is not in my province to recommend what pipe should be used, but I would like to say a few words about my troubles and the remedies I found.

Without going back too far I will say that twelve yeas ago we found that lead and galvanized pipes were not suitable to the water with which we were supplied and I began to use black wrought iron pipe lined with cement to the exclusion of other materials. The pipe itself has given excellent service, but at points where it entered a brass stop or fitting we often found the pipe at the thread eaten completely away and the fitting almost filled with deposited material, resulting in badly weakened pipe and many complaints of poor pressure.

To overcome this I devised forms for lining stops and fittings with lead. Now we have a service in which from main to meter, the water passes through walls of brass, lead and cement. No water comes in contact with iron at any point after it leaves the main. The difference in potential between brass and lead is small enough so that we need not worry about violent galvanic action between these metals.

We use black wrought iron pipe plugged and reamed, in about 15-foot lengths. Natural Rosendale cement was found best for lining because it sets much more slowly than Portland and, therefore, does not require as frequently mixed batches. The lining apparatus consists of a screw piston ram or gun, set above a bed in which the cement is mixed, and a cone which is pulled through the pipe after being filled with cement, making the waterway. The cement after being mixed in the bed is used to fill the gun. When operated it forces the cement into the pipe which is screwed into the end of the gun. The pipe is then removed and placed in a vise which is conveniently placed and the cone attached to a long leading wire is pulled through. The cones are made in such sizes as will allow a one-eighth inch coating all around the inside of the pipe.

After being allowed to set up for four or five days the ends are turned up, the pipe cleaned and given a coat of tar paint.

The successful use of cement-lined pipe demands careful installation. Wheel cutters should not be used when breaking lengths. We use a square edge cutter. A file is also used to make certain there are no ragged edges.

I feel quite sure that carefully installed cement-lined pipe used in connection with lead-lined fittings and stops is the pipe for services which will give most satifactory results under the widest variety of conditions.

MR. WM. G. SCHNEIDER (Copper and Brass Research Association, New York): The last paragraph of Mr. Donaldson's paper on water service pipes refers to brass when used for such purpose. It is true that brass for service lines has not been extensively used. This is due to the fact that it has not received the consideration which it deserves, and that it is a new comer in this field. That it will be more extensively used in the future is certain, especially as its many advantages become more apparent.

A comparison of its advantages, and disadvantages, if any, with the other piping materials discussed in Mr. Donaldson's paper makes it obvious that brass and copper pipe do deserve consideration, not only for certain service pipe installations, but also for plumbing pipe.

Mr. Donaldson points out that galvanized pipe soon rusts and corrodes, becomes rust-clogged, and that red water appears at the faucet. Brass and copper pipe do not rust or become rust-clogged and no red water is discharged at the faucet where it is used, provided the plumbing pipe in the house is also of copper or brass. Brass pipe is easily installed, and presents no difficulties in its handling that are not experienced with galvanized pipe.

Annealed copper pipe is used for service lines and is a most satisfactory installation. In addition to its resistance to corrosion it is ductile and therefore may be bent to the main, eliminating the lead gooseneck.

Brass or copper does not have the serious drawbacks that are experienced with lead, as brought out by Mr. Donaldson. There are thousands of installations of brass or copper plumbing pipe in this country, but not a single complaint is recorded against these materials from a sanitary or health standpoint.

Any apparent disadvantage of greater initial cost for brass or copper is not a serious factor when carefully considered. Compared to galvanized iron, brass or copper pipe costs slightly more than twice as much. When installing service pipe the cost of the piping material is a very small part of the final cost of the job. For example, a comparison of costs of galvanized iron, brass, copper and lead services based on a 50-foot length, without connection to main, gives the following:

	IRON	BRASS	COPPER	LEAD
1 inch pipe and fittings	$6.50	$23.50	$26.00	$22.00
Assumed cost of installing at $3.00 per foot*	150.00	150.00	150.00	150.00
	$156.50	$173.50	$176.00	$172.00
Cost of pipe and fittings *per cent*	4.15	13.55	14.75	12.80

* Where resurfacing necessitates exceptionally fine pavement the $3.00 charge may be much higher.

Taking the galvanized iron installation as a base:

Brass costs ..... about 10.9 per cent more
Copper costs ..... about 12.5 per cent more
Lead costs ..... about 9.9 per cent more

The above costs for brass pipe are based on mixtures regularly supplied for plumbing purposes. Where such mixtures are not suitable, due to exceptional water conditions, such as the circulating of sea water, the prices quoted for copper approximate the cost for the higher copper content brass pipe.

In other words, the house owner may install copper or brass service lines for about the same cost as lead, with none of lead's disadvantages. Where the installation costs $100 with galvanized iron, copper or brass may be installed at an additional cost of about $12, giving a permanent installation free of rusting or rust-clogging that will not require subsequent replacement.

MR. WELLINGTON DONALDSON: In connection with the subject of lead solvency, certain data reported by Bunker (in a paper in Water and Water Engineering, January, 1923) are interesting. These figures deal with the Agua Clara supply of the Panama Canal Zone, which, after being treated with soda-ash and alum, aerated and

settled in basin, has a pH value of 5.5, 4 p.p.m. alkalinity and 4.5 p.p.m. CO_2. Filtration followed by a lime dose of 0.3 g.p.g. results in pH 9.0, alkalinity 15, monocarbonate alkalinity 3.0 p.p.m. Bunker found that even with this amount of monocarbonate alkalinity, 0.5 p.p.m. lead was taken into solution from new services during the first three months after installation, although 0.1 p.p.m. was the maximum amount present in conditions of ordinary day use from old services. These results were considered sufficient grounds for the recommendation to discontinue use of lead service pipe for the Agua Clara supply, although no cases of plumbism were known to have occurred.

Another interesting result reported by Bunker was that traces of residual chlorine in the filtered water did not increase plumbo-solvency.

Illustrating the unsuspected existence of plumbo-solvency in many communities, where special attention has not been given to the subject, is the case of a town in South Carolina, recently reported by Morrison in "Water and Light" of April, 1924 issue. Here the water supply, derived from wells 40 to 60 feet deep, is "unusually soft and pure." Lead goose-necks or service connections, "extra heavy," began to give way after seven year's use and when examined were found to be nothing but a shell, pitted on the inside like smallpox. Lead joints in the water mains were similarly attacked. Feeding soda-ash at a dosage of 1.2 g.p.g., during the past four years, has apparently stopped corrosion of lead in the distribution system. The existence of possible lead poisoning in the city was not discussed, and one is left to his own speculation as to whether such relatively large amounts of metallic lead can be dissolved in seven years' time without detrimental effect on consumers.

The case just cited is by no means an isolated one, but serves to emphasize the importance of water works operators, having to deal with soft supplies high in color or carbonic acid, making a careful investigation to determine the action on lead and applying remedies necessary to establish immunity from possible poisoning.

It is of considerable significance that the revision of the United States Treasury Department standard for quality of water furnished by interstate carriers takes cognizance of metallic and mineral impurities as well as bacteriological condition.

The practical effect of this standard would be to direct attention to metallic content of water supplies which heretofore has been in large part neglected both by the water analyst and by health officials.

DISCUSSION OF REPORTS OF COMMITTEE NO. 7 ON PUMPING STATION BETTERMENTS[1]

MR. LEONARD A. DAY: The work of the Pumping Station Betterments Committee this year consisted mainly in the preparation of four papers relating to our subject. The first paper which was written was the selection of auxiliaries for steam operated pumping stations, by F. G. Cunningham;[2] The second is "The Electric Pumpage at Kansas City," by A. L. Maillard,[3] the third was "Some Experiences with Steam Turbine Driven Centrifugal Pumps,[4] by the speaker, and the fourth was "Diesel Engine Driven Pumping Station" by W. DeW. Vosbury.[5]

MR. J. N. CHESTER: With the Diesel engine paper[5] just read, fresh in my memory, I shall bring out such points as impressed me in that first, and will then revert to those I will discuss from the printed page. Having had no experience with Diesel engine drive pumping stations, but the nearest being with gasoline and natural gas actuated engines, I can only draw some conclusions and comparisons from that source. My first mention is this: we have several gas engine driven pumping stations. We resort to gasoline only when the gas during the winter time goes short, and the one thing is the difficulty of obtaining men in an emergency to operate those engines. True the automobile expert has made this field a little more fertile than it formerly was. Notwithstanding even that, where you have a station in which only one engineer is needed, it being a reservoir, and, with an eight hour shift, a supply can be pumped, when that engineer goes down there is sometimes a hustle and a difficulty to find somebody to take his place. That has happened to the extent that we have adopted the plan that the superintendent himself must be a competent gas engine engineer, and he is the man who must alternate with the engineer when the engineer is out of service.

[1] Presented before the New York Convention, May 23, 1924.
[2] Journal, March, 1924, page 341.
[3] Journal, May, 1924, page 542.
[4] Journal, May, 1924, page 548.
[5] This Journal, page 381.

Naturally in the paper where it has been shown that electricity was produced at five-tenths of a cent or five mills per kilowatt, we can only decree that that operating cost, plus a fair maintenance, must be considerably less than usual. It would seem to me that, within the zone of our large centrally organized electrical properties, the Diesel engine driven pump would hardly be practical, and especially when you add the burden, that it would add, to the conclusions drawn by the author of this paper.

When we first began incorporating in the equipment of our plants a Ford machine, we were led to believe by Mr. Ford's agent and others, that the machine was a four year entity and that we should figure the depreciation accordingly. Ten years employment of that creature has led us to the plan of turning in our Fords at the end of the second year and receiving therefor $125 in credit on a new machine; consequently we depreciate them now on the two-year basis with a junk value of $125. Now to the author of the Diesel engine paper and to others contemplating it, I believe you are going to find the Diesel engine something in the line of the Ford machine. I can only give you as a point to serve my argument the fact that fifteen years ago, at Edgeworth, Pa., we installed as high a grade of gas engine driven equipment as it was possible to purchase, and for four or five years we ran along with practically no maintenance. There was the grinding of the valves and little wearing parts and all those things that you fellows who run automobiles know about, and then amortization set in in earnest, and when I tell you that, when we passed the tenth year, maintenance of the equipment in the last five years for every year has far surpassed the other operating expenses, that is, it has surpassed the cost of the fuel and the cost of the men to operate that station. Last year it was five thousand dollars, and it is only the fact that that situation is hanging along because the Pennsylvania Railroad has surveyed a six track right of way right across it and expects to give the company a new station for the old one, that we have tolerated that kind of maintenance cost. I tell you that so that you will not think we are crazy for not having replaced it before, but I think 15 years is probably a high average life for the Diesel engine. I fear that within that time, like the Edgeworth, Pa. gas engine driven station, the cost of maintaining that plant will have mounted to a place where you will be convinced that the useful life of that kind of equipment, especially the Diesel engine itself, is closer to ten than fifteen years.

With regard to Mr. Day's paper on Turbine Tests,[4] that struck me as a very interesting and exceedingly extraordinary phenomenon to have occurred. Associated for many years as I have been with the turbine driven equipment, we arranged through Mr. Biggs, the Chief Engineer of the American Water Works and Electric Company, that a second test be made of the turbines at Birmingham, Ala., which was done. Absolutely contrary to Mr. Day's experience at St. Louis, no such interferences with economy were discovered. In fact the second test a year after was approximately the same as the first or the original.

The second test simply verified the first. In other words, the test of each engine was just a little different from the orignal test for acceptance, and made on the same basis as the original test for acceptance of those machines, indicating practically no change in the turbine economy within that year, and no scaling or corrosion.

At Erie, Pennsylvania, we have been unable to find anything of this kind. Both stations use superheated steam, and if I had been told of this without seeing Mr. Day's tabulation of the test, wherein some 80 degrees of superheat was used, both during the formation of this scale and during the test afterwards, my first question would have been, "Why not superheat the steam and thus remove all evidence of scale?" Further than that I would not have been able to comment. It is a mystery to me just how it gets through at St. Louis, even though Mississippi River water is there used. At Erie we have lake water and at Birmingham they have water from Lake Purdy and the Catawba River, which seem to me are all the same when you get them into superheated steam.

Mr. Cunningham's paper on Auxillaries for Steam Operated Pumping Stations[2] is what I would call a good general outline and discussion of pumping station auxilliaries. It is splendidly prepared and certainly brings the subject before the unthinking, at least, in a way that will cause them to study and give more attention to the selection of auxiliaries. As I go around the country and visit different stations, it seems to me that that is the one thing that has been ignored, or that has been generally left to the manufacturer, who, we will say, generally puts in the kind of a condenser, air pump or circulating pump, which is the nearest on the shelf when he selects the machine he is going to offer. Out in the engine room or the boiler room you will find the kind of a boiler feed pump that the most adroit salesman has been able to offer to the operating engineer or the superin-

tendent. I cannot better illustrate that than by saying that I found a good many non-conducting turbine driven boiler feed pumps in small stations, which I consider is about the limit of benighted ignorance in boiler feed pumps or boiler room practice, for the ordinary sized water works.

We also find a good many electric light units operated by non-condensing turbines. Now if you have a large pumping station and directly connected everything in that room and a big boiler plant and no other means of obtaining boiler feed water heat, we might justify such equipment, but in every case where I found these I believe I found a goodly portion of steam shooting out through the exhaust, having first passed through the heater. I simply bring it up to show the extreme in one direction.

The heat balance brought out by Mr. Cunningham is based, we believe, on a new station, which unfortunately few of us have the opportunity to design and create. Ninety per cent of all the engineer's activities are in designing additions to old stations, and therefore we must first consider what we have, and then compute the makeup in the new equipment. My discussion is more generally on the differences I have with the author of the paper than praising its good points.

Take the matter of heating the station, which I never consider in determining heat balance. Heat for the station is seasonal, and if you consider it and balance it for the winter time, you are out of balance badly in the summer time. I argue therefore that, if I can recover or salvage the hot water from my heating system and get it back to my heater, since we use steam for heating only in the winter time, and I can then put that much extra back, I can just about provide the additional heat needed in that best balance due to radiation of cold weather, over what we would need in the summer time. We generally forget, therefore, the amount of heat required to heat the station or the filter building or anything else round about, and simply say we will have that as a contribution in the winter time to make up extra radiation.

My differences with Mr. Cunningham and the impressions that I have gained from reading his paper are principally in the condensing equipment. There has been brought forward in the last year or two, especially in turbine driven equipment, the matter of the extension of the shaft and the addition of a circulating pump and the use of what he terms the Marine type of condenser. To me this is the

ordinary type of engine room condenser wherein the circulating water goes through the tubes, instead of, as in the water works type, where it goes around the tubes. With something over 200 pump installations to my credit, I must declare I have never found occasion to use but once any other than the water works type of condenser. I feel a good deal like the fellow who was quoted $2500 on a sawmill for sawing up a certain piece of timber and wrote back to say, "If I had $2500 what do you think I'd want of a sawmill?" And if I have a water works problem of 20,000,000 gallons and under, I can only reply, "what do you think I need with a circulating pump when I can place that condenser in the suction or discharge and utilize the water pumped by the main engine for circulation purposes?"

I am not going to say for a minute that, if I put in a pump of 110,000,000, as I believe Mr. Day has to lift the water out of the Mississippi River to the settling basins, I would consider a water works condenser. I know I would not. The volume to go through the condenser has much to do with the problem and when the cooling capacity is so small in proportion to the amount of water that must pass through naturally, we go over to the other type of condenser. Let me state here that my installations to date have been limited to a capacity of 30,000,000 and I have always found means of making the water works condenser applicable, although I have given study to the other type.

Let us consider the low service pump; we are drawing our supply from storage or a running stream and have more or less trash trouble; we naturally say "screen it out," but when you take that water, even out of your suction, and try to drive it through the tubes and the condenser, you will find there a screen that is constantly stopping up, for strain the water as well as you can, you will have sufficient material left to stop up the tube head in the power type of condenser. It is not easy to clean, but if you put it through the water works type, you will not need to clean it, because any water works type of condenser should pass through to the settling basin anything that would pass the screens, where the other condenser would arrest it and necessarily you would have to shut down to clean. I have seldom been confronted with the necessity of supplementing feed water heat by drawing from the boilers. I generally find more trouble in providing some means of disposing of what I have left from the auxiliaries and prefer to generate within the station the electricity necessary to light that station, even though it could be bought at a very reasonable

price, and so use the exhaust steam from that engine to make up my heat balance, rather than to draw direct steam from my boilers, or, we will say, from the intermediate stages of our pumping equipment. I do not like taking steam from the receivers of either the turbine or the pumping engine unless I know that the same amount is to be withdrawn or in the same proportion to the horsepower that that machine is generating. That I have not found possible, because some day when you are pumping slowly with one machine you are drawing from and pumping hard with some other machine and you are throwing that machine out of balance by taking the steam from its receiver. I have frequently found reason to use a pressure heater and put a little back pressure on my auxiliaries and discharge the steam waste or heat back into the receiver of some engine and thus shorten up the cutoff, and get the benefit of it in that way rather than taking out enough to make up a deficiency.

This is a long paper and contains a good many other things in the way of stokers for coal handling equipment, and such things that do not interest many of you. It is only in the larger stations that you put in stokers. It is only in the larger station that you have coal and ash handling machinery, and in as much as there are as many different methods of driving those elements as there are different types of machines made, of course, steam driven equipment is applicable whenever your equipment permits, but we have the water wheel and electric motor and other ways of driving, and I am going to arrive at the same conclusion that Mr. Cunningham reaches, to wit, that every different boiler and engine room is a problem by itself.

MR. KERR (General Electric Company, Steam Turbine Department): The experiences of Mr. Day have been the subject of a great deal of study by turbine manufacturers. We have to furnish turbines for operation under a variety of conditions in various parts of the country, and it really comes down to a question of feed water conditions. The first thing we recommend is a rectification of feed water conditions. Another thing is the proper separation of foreign matter between boilers and turbines. Now we must bear in mind that superheated steam does not necessarily mean clean steam, neither does it necessarily mean dry steam. Under ordinary conditions, yes; but under sudden fluctuations or things of that kind, no. We have no control other than to make recommendations concerning the water conditions. Therefore, our

method of attacking the problem has been to make our equipment as accessible as possible. We have split all the stationary elements of the turbine; that includes the casing, the diaphragms and the packing. We have separated the external shaft packing boxes from the casings, so that with moderate attention, which one would expect to give to machinery and an inspection with a frequency depending upon the conditions under which the turbine is operating, there should be no difficulty such as experienced by Mr. Day. There will be deposits, but, if the inside of the turbine is inspected once in a while, the deposit does not reach such an extent that it cannot be removed easily. Of course, that is the trend of modern design of any kind of mechanical equipment, whether automobiles or anything else, because we realize that anything mechanical is not 100 per cent right, and we must be able to get into it and look at it. I might say here that these experiences are not confined to any one class of installation, or any one particular make of turbine. We find it in our central station practice. Central station men have come to realize it and I might further say that the accessibility feature of the turbine has not been solely because of the desire of the manufacturers, but by the demand of the trade.

There is another point that came up in Mr. Chester's discussion of Mr. Cunningham's paper, and that is the queston of extraction from turbines. I believe, of course, it depends entirely on each individual station, but the central station men have found this to be more desirable than depending upon steam from the auxiliaries, because they have absolute control over it. Of course, as I said, this is subject to variation in individual plants.

MR. ISAAC S. WALKER: The hour is getting late and I do not believe I have anything to offer at this time of special importance, other than that Mr. Vosbury had a rather strenuous time of it when he started this Gloucester Diesel Engine pumping station in operation. Perhaps a word from him on that might be of interest, as he did not elaborate on it to any great extent in his paper.

MR. W. DE W. VOSBURY: As Mr. Walker has intimated, we did have a strenuous time in starting the Gloucester plant. A great deal of dissatisfaction existed among the employees. They were men who had experience in steam operated plants only; consequently they looked upon the new Diesel plant with distrust. In addition, it was known that there would eventually be a reduction in the

number of operators and that at least one-half of their number would lose their positions.

I would not want to say that there was any ulterior motive in their attitude or that there were any direct attempts to discredit the plant. There were rumors circulated however, which came very nearly convincing the public that the new plant was too complicated and that it would not run or at best that it would prove to be unreliable.

A few weeks after the plant has been in operation the governing body of the municipality introduced and passed an ordinance reducing the number of employees at the station from fifteen to seven. Within a few hours following the passage of this ordinance word was received that the men were going out on a strike and that the plant would be unattended. To relieve the situation I sent for one of my assistants who had supervised the construction of the station and was therefore thoroughly familiar with it. This one man operated the station unaided for nearly three days and at no time did he require the aid of an assistant, as there was very little to be done. The station practically runs itself.

The only regular duties of the attendant, outside of occasionally filling the auxiliary fuel oil tanks is to watch the temperature of the cooling water, keep the equipment clean and to change over the pumps now and then to conform to the variation in demand.

After an engine has been in continuous operation for a period ranging from six to eight weeks it becames necessary to shut it down for over-hauling. This consists principally in the grinding of the valves and minor adjustments. An inspection is also made of the main bearings. Now that everything is running smoothly some of the incidents which occurred during the first few weeks of operation are, upon reflection, very amusing.

One such incident occurred shortly after the strike, which I have referred to above. It had to do with the engine which had been giving trouble in speed regulation. Even after the source of the trouble had been found and eliminated it was apparently impossible to keep it in operation for a period longer than a day or two. Finally, however, with a change in operators the trouble apparently ceased and the engine continued to run. To make a long story short, it ran for so long a time that I began to wonder. Finally a request was sent to my office for someone to come to the plant and shut the engine down. The truth of the matter was that it had continued to run because the new operator either did not want to assume responsibil-

ity or did not know how to stop it. Once a reputation for reliability had been established by this engine we had no further trouble with it.

MR. JAMES E. GIBSON: I do not think that I can add anything to this discussion. The paper is very full and had been discussed very ably. There is one thing, however, that we must all bear in mind and that is continuity of service. I mean service to the people. When we are operating a water works plant we cannot look too longingly at the economical standpoint. It is a good thing to have economy in mind at all times, but continuity of service should be our watchword, for when we do not get water to our consumers they are not going to take excuses based on an economy standpoint, and more than likely their reply will be that they are paying their bills and they want the water.

MR. R. D. HALL: I was much interested in Mr. Cunningham's paper and in Mr. Chester's shelf of condensers to which you just reach up for appliances to your engine. My experience more or less coincides with his, at least on reciprocating pumping machinery. It is the exception rather than the rule. In fact, I cannot recollect when we have installed anything other than water works types of condensers on a municipal pumping unit of the reciprocating type. I think the Marine type of condenser was coupled rather with turbine practice, and in that respect has crept into steam turbine driven centrifugal installations. I do not imagine that it will survive to the extent that the water works type of condenser will. As far as the same shelf goes, we ordinarily equip the units in formal installations with what the engineers ask us to do, but the specifications at present are almost entirely confined to the water works type. I could quote Mr. Chester again, which he forgot to say, that in the past there has been altogether too much attention given to the refinements of the main unit, the primary mover, and too little attention to trimming our sails with respect to steam consumption of auxiliaries. I think that the future development of the art will take great cognizance of economy of low service units. The field for improvement in low service units with respect to steam economy is very great and more or less unexplored on the part of pumping machinery manufacturers.

MR. L. F. ADAMS (General Electric Company): Mr. Cunningham states that electrically driven apparatus should not be used where absolute continuity of service is required, as for condenser auxiliaries of high service pumps delivering water directly into the mains.

It does not seem that the question of reliability of the auxiliaries in a steam driven pumping plant could be of more importance than it is for the auxiliaries of a large steam generating station. In the latter, the present trend is towards the elimination of the small steam driven auxiliaries and the use of motor driven auxiliaries. The conditions which have caused this trend in large steam generating stations should apply to a great extent in steam operated pumping stations.

Mr. Cunningham also mentions the possibility of interruption in electrical power circuits due to the blowing of fuses and similar causes. It is not desirable to include fuses in any of the axuiliary circuits, but to protect the motors by means of overload relays, preferably of the thermal type, so that the motors would not be shut down unless dangerous overheating occurred. A reliable source of power can be secured for these auxiliaries.

In the case of large steam driven pumping units, one of the best methods would be to have a generator connected to each main unit, this generator supplying power for all the auxiliaries of that unit and possibly large enough for the auxiliaries of more than one unit. This method enables the steam required for generating power for the auxiliaries to be used in the most efficient unit, which is the large turbine driving the main pumps.

Where the pumps are run at constant speed, alternating current can be used, but where the main pumps are run at varying speeds, direct current is preferable, as by selecting the proper generator, the voltage can be held throughout the entire range of speed. Where auxiliary power is generated in this way, it is usually necessary to have one stand-by unit connected to a non-condensing turbine so as to enable the plant to start up after an entire shut down. This should give a system using motor driven auxiliaries equally as reliable as any system using steam driven auxiliaries.

MR. A. PETERSON (DeLaval Steam Turbine Company): Mr. Cunningham should be complimented on his paper, which is very well written and complete, and I fully agree with him that the purchaser should specify definitely what kind of auxiliaries he wants.

As regards auxiliary turbines for high steam pressures and superheats, there are today available such turbines that are mechanically just as reliable as the main units.

From the comparative power requirements of condenser auxiliaries, as tabulated on page 353 of the March, 1924 JOURNAL, I note that the water turbine for driving the condensate pump has an efficiency of 87.5 per cent, which looks rather high for a 7 h.p. water turbine.

I assume that the power required by the hydraulic air pump, using water from the mains, should be 5 water horse power instead of 5 b.h.p., and the same should apply to the water turbine driven centrifugal condensate pump, using water from the mains. This pump requires 2 b.h.p. and based upon 50 per cent efficiency of the water turbine 4 water horse power should be charged instead of 4 b.h.p. The amount of steam charged against the main unit, however, is correct.

Regarding boiler feed pumps, while centrifugal pumps for capacities below 100 g.p.m. are not very efficient, such pumps have, however, been built, which are perfectly satisfactory, both mechanically and in maintained efficiency. The writer is familiar with small centrifugal boiler feed pumps, which have been in continuous operation for more than ten years, delivering less than 50 g.p.m. The width of the impellers at the periphery is more than a quarter of an inch and no trouble has been experienced with erosion or scale deposits.

I am sorry that I did not have more time to prepare a discussion, but as stated above, the paper is so well written and complete that there is really not much left to discuss.

DISCUSSION

TOTAL ALUMINA IN WATER (MODIFIED ATACK'S METHOD) COLORIMETRIC DETERMINATION

Reagents

1. Three-tenths per cent aqueous solution of alizarin red S (alizarin sodium monosulphonate).

2. Five per cent ammonia water free from alumina. Reagent ammonia must be distilled and kept tightly stoppered in hard rubber bottles.

3. Alumina free water for comparison standards (less than 0.06 p.p.m. Al_2O_3). The same type water in which the alumina is to be determined is allowed to stand in a fairly warm place for at least forty-eight hours and then filtered through packed asbestos. It is well to use a glass cylinder 2 inches in diameter by 12 inches long for the filter. Grind a $\frac{3}{8}$ inch hole in the base, in the center of the cylinder for a rubber tube connection. Place a perforated porcelain disc in the bottom of the glass cylinder and pack asbestos on top—the coarse first and then the fine. The depth of the asbestos should be at least 2 inches. Maintain at least 4 feet of head on this filter by means of a glass tube and rubber stopper connection in the upper end of the cylinder. The glass tube is connected to the lower end of a large funnel or similar reservoir which should be placed about 4 feet above the filter. The rubber tubing which connects the lower end of funnel with the upper end of the glass tubing should have a clamp with screw adjustment over it—this acts as a rate controller. The filtered water should be tested for alumina by using the method and comparing with standards—one made with distilled water and no alumina and the other with distilled water and 0.005 mgm. alumina (0.5 cc. of an aluminum sulphate solution, 1 cc. of which = 0.01 mgm. Al_2O_3).

4. Twelve per cent sulphuric acid. This should be made from the highest grade reagent acid and boiled distilled water.

5. Fifty per cent acetic acid made from the highest purity glacial acetic acid and boiled distilled water.

6. Aluminum sulphate solution for comparison standards. Dissolve 0.326 gram of 17 per cent filter alum (which is very white) in 500 cc. of boiled distilled water. One cubic centimeter of this solution = 0.1 mgm. Al_2O_3. This is too strong to use. Dilute 50 cc. of this strong solution with 450 cc. of boiled distilled water. One cubic centimeter of this solution = 0.01 mgm. Al_2O_3.

Procedure

To 50 cc. of the freshly collected and well shaken water add 1 cc. cc. of 12 per cent sulphuric acid. Boil the solution down to 40 cc. in a flat bottom spherical-shaped flask. A flask of 200 cc. capacity with a mark to show when the solution has been reduced to 40 cc. should be used. Add 1 cc. of 0.3 per cent alizarin red S solution and just barely neutralize by adding, drop by drop, 5 per cent ammonia water. When the solution is neutral, as indicated by the change from yellow to purple, add exactly 0.3 cc. excess of the ammonia and boil two minutes, remove from the hot plate, add 0.1 cc. ammonia and cool quickly by placing flask in a shallow pan containing ice water.

When the temperature has dropped to 20°C., add 1 cc. of 50 per cent acetic acid and compare with standards which have been treated in exactly the same manner. It is very important to make comparison within one minute after the acetic acid has been added.

F. O. Baldwin.[1]

[1] Superviser of Water Purification Plant, Department of Public Utilities, Richmond, Va.

ABSTRACTS OF WATER WORKS LITERATURE

FRANK HANNAN

Key: American Journal of Public Health, 12: 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the Journal.

Third Annual Report, Ohio Conference on Water Purification, 1923. 1924; 90. Activities of Phenols Committee regarding progress in efforts to correct contamination of water supplies by wastes from by-product coke ovens are outlined, and practical problems at various plants in state discussed. Important conclusion reached was that individual administration of iodine for prevention of simple goiter was preferable to medication of water supply. **Water Purification at Toledo, Ohio, 1916–1923.** R. W. FURMAN. 33–8. Maumee River water is subject to extreme variations in quality; great difficulty is experienced in effecting coagulation, up to 10 grains of alum per gallon being required. Secondary coagulation is not effective. When turbidity of filter influent is much in excess of 25 p.p.m., filtration efficiency is impaired. Combined softening and coagulation with lime and sulfate of iron in 1915–6 resulted in incrustation of sand and deposits of calcium carbonate in filter underdrains and piping, necessitating reconstruction of filters. Subsequent use of lime and iron sulphate again resulted in deposits of carbonate on sand grains, a large part of which was removed by employing aluminum sulfate as coagulant. Lime and iron sulfate is now used for 5 months and alum during remainder of year. During winter of 1919–20 disagreeable tastes and odors occurred as result of anaerobic decomposition of organic matter, due to prolonged ice-bound condition of river. **A Study of the Behaviour of the Carbonator of the Defiance Water Softening Plant.** H. T. CAMPION. 39–42. During past year 200 pounds of coke were consumed per million gallons treated, cost for coke being $1.29 per million gallons. Gas is applied through filtros plates under 10 feet of water; approximately 80 per cent of carbon dioxide delivered is absorbed. Average analyses of water before and after carbonation, former after softening with lime, coagulation with alum, and settling, and latter after filtration, were respectively: alkalinity (total with methyl orange) 52, 53; basicity (monocarbonate alkalinity) 42, 0; causticity (hydrate alkalinity) 10, 0; free carbon dioxide 0, 2.5; total hardness 130, 135. Influent to carbonator contains finely divided white turbidity which cannot be removed without liberal doses of coagulant. Carbonation dissolves this turbidity and improves flocculation of coagulant, facilitating filtration. Little or no change has occurred in sand during two years of operation. **Investigation of Difficulties in Properly Chlorinating the Filtered Water During the Summer Months at the Toledo Filtration Plant.** R. W. FURMAN. 43–6. For several years,

city tap water has shown greater number of bacteria per cubic centimeter (particularly the 20° count) during summer months than chlorinated filtered water leaving the plant. Non-spore-forming gas-formers which ferment only after 48 hours incubation, but respond to all usual confirmation tests for B. coli have also been noted in treated water. Chlorine applications of 0.5 p.p.m. have failed to remedy the condition. Double chlorination at widely separated points is a promising solution to problem. **Further Studies on Comparison of Double Coagulation and Single Coagulation of Ohio River Water at Portsmouth, Ohio.** F. E. SHEEHAN. 47–61. Portsmouth plant consists of two settling basins operated in series; 8 rapid sand filters; and sterilization equipment. Experiments were carried out varying method of applying coagulant; present practice of double coagulation, adding 60 or 75 per cent of required dose in first basin and remainder in second, was found to be most efficient and economical. Application of total dose in primary basin did not produce uniformly satisfactory filter effluent; while its application in secondary basin gave satisfactory efficiencies only when B. coli content of raw water was less than 10 per cc., and unduly increased burden on filters. Ohio River water averaging 50 B. coli per cubic centimeter may be successfully treated by double coagulation, sedimentation, and filtration, independent of sterilization process, which may be employed as a true factor of safety. A practical limit for B. coli content of filter influent under such conditions would be 80 per 100 cubic centimeter. Bacterial counts at 37° indicated somewhat higher removals than those at 20°, and B. coli tests showed highest efficiencies. **Method of Carbonation of Lime Softened Water Proposed for Use at Columbus to Prevent After-Reactions, Deposits on the Sand Grains in the Filters, and Deposits in the Distributing System.** CHARLES P. HOOVER. 62–3. Excess carbonation of portion of supply and subsequent mixing with balance proved unsatisfactory. Experiments indicate that chimney gases, after scrubbing, are sufficiently pure for carbonation of softened water; as carbon monoxide is comparatively insoluble and sulphur dioxide easily removed by washing. Details of the diffusers, consisting of cemented sand, are given. **What Constitutes Good Laboratory Technique in Bacteriological Examination of Water? A Discussion and Demonstration.** C. T. BUTTERFIELD. Proper procedure is described for preparation of pipettes, sterilization of glassware, collection of samples, adjustment of media, plating, inoculation of tubes, making dilutions, incubation, and confirmation and interpretation of fermentation tests. Sterilization of glassware should consist of heat treatment at 170° for at least 1½ hours. Recommended pH range for media is 6.5 to 7.2, preference being given to pH 6.8. Final reaction of Endo media should be pH 7.8–8.2. Samples should be diluted to give plate counts between 30 and 300. **Progress in Studies of Limitations in Efficiencies of Water Purification Processes.** H. W. STREETER. 67–9. Studies of relationship of sewage pollution to purification plant efficiency, begun prior to the war, will be resumed. Investigation will consist of operation of experimental rapid sand filter under conditions permitting accurate control of quality of raw water, and intensive study of operation and efficiencies of 16 representative purification plants. **Corrosion.** C. W. FOULK. 70–5. From pH 5 to 11 rate of corrosion is independent of hydrogen-ion concentration, controlling factor being concentration of dis-

solved oxygen and its rate of replenishment in film immediately adjacent to iron. Oxygen oxidizes ferrous hydroxide to ferric, destroying equilibrium and facilitating further solution of iron, and also oxidizes liberated hydrogen which otherwise would have polarizing effect. At pH greater than 11, polarizing film is removed by oxidation as rapidly as formed; while below pH 5, film is destroyed by escape of hydrogen as gas. Rates of corrosion (sub-aqueous) of wrought iron and steel are approximately equal. Methods of prevention include; encouraging deposition of protective coating by the water; removing dissolved oxygen; and, in boilers, use of zinc plates with or without applied current. Brittling of boiler metal is caused by presence of large amounts of sodium carbonate, and may develop when permutite-softened water is employed. **Simple Goiter—An Iodine Starvation Disease.** 76–82. Occurrence of iodine in nature and its relationship to simple goitre is discussed. Use of sea salts in toto, as condiment, is suggested as means of correcting deficiency of iodine in modern diet. Average salinity of sea water is 3.4404 per cent consisting of sodium chloride 77.8 per cent, magnesium chloride 10.9 per cent, other compounds, including sodium iodide, 11.3 per cent. Iodide is seldom present to any extent in natural salt deposits owing to its great solubility, and, when present, is usually removed by refining process. **Endemic Goiter as a Public Health Problem.** O. P. KIMBALL. 83–5. The most important facts regarding the thyroid are summarised; relationship of iodine occurrence to prevention of goiter discussed; and administration of iodine as prophylactic measure reviewed. Approximately 1 mgm. of iodine per day, or 100–200 mgm. administered twice yearly, is sufficient to keep the thyroid saturated and prevent goiter. Adolescent goiter can best be controlled through the schools. Treatment of water supply with sodium iodide is too costly and involves great waste, only 4 ounces of every 100 pounds applied being actually imbibed, and only 15 per cent of this 4 ounces really needed. **The Use of Iodine in Public Water Supplies to Prevent Goiter.** J. W. ELLMS. 86–7. During period Sept. 11–Oct. 2, 1923, approximately 75 parts sodium iodide per billion was applied daily to water supply of Rochester. Method of application consisted of suspending the salt in bag, back of dam at entrance to reservoir, entire daily quantity (16.6 pounds) entering reservoir within a few minutes. Sodium iodide content of tap water, gradually increased from 4–5 to 50 parts per billion, and, when treatment was discontinued, gradually decreased, reaching normal content on October 19. Maximum of 50 parts was only maintained 4 days and average was approximately 30 parts. It would cost $12,750 to treat Cleveland water supply of 150 million gallons daily in a like manner for a period of 30 days each year, and it would seem more effective and less expensive to treat the individual directly for simple goiter than to attempt medication of water supply. **On the Application of Iodine to Public Water Supplies.** CLARENCE BAHLMAN. 88–9. Discussion of previous papers. Treatment of supply of Cincinnati on the basis of Rochester experiment would cost $10,000 per year, representing an increase of 10 per cent in filter plant operating expenses. Use of iodized salt is considered a more reasonable procedure. **The Seal of Safety Indicates a Good Water Supply.** W. H. DITTOE. Activities of Engineering Division of State Health Dept. in examination of water supplies in communities not provided with public supply are outlined.—*R. E. Thompson.*

Experiences in the Campaign against Goiter among Young Girls above School Age by Means of Iodine Tablets. W. SILBERSCHMIDT. Schweizerische med. Woch., July 5, 1923; Bull. mens. office internat. d'hyg. publique, **15**: 1376, 1923. Describes use of chocolate tablets containing 0.5 mgm., I, at rate of one tablet per week for two years. Results good with girls from 15 to 21 years of age, but not so good as with younger children. Advises against too great expectations from use of iodized table salt, which is however, free from danger. Less satisfactory results are to be expected in relieving goiter among adults than among children.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abt.*)

Regarding the Goiter Problem. O. BAYARD, Schweizerische med. Woch., July 26, 1923, p. 703, and August 2, 1923, p. 732; Bull. mens. office internat. d'hyg. publique, **15**: 1374, 1924. General paper on goiter, last part of which discusses goiter prophylaxis and rôle of I.—*Jack J Hinman, Jr.* (*Courtesy Chem. Abst.*)

Telechron Electric Position Transmitter. ANON. Water and Water Eng., **25**: 473, 1923. Illustrated description of electric indicating gage, for showing at a distance height of water in reservoirs.—*Jack J. Hinman, Jr.*

Estimation of Carbon Dioxide in Drinking Water. P. LEHMAN AND A. REUSS. Zeit. f. Untersuchung der Nahrungs-und Genuss-mittel, **45**: 227, 1923. Water and Water Eng., **26**: 39, 1924. For combined CO_2, two or three drops of Me orange (aqueous, 0.01 per cent) are added to 250 cc. H_2O and titrated with N/10 HCl. For free CO_2, 200 cc. H_2O are treated with 1 cc. Tillmans and Hueblein's phenolphthalein soln. (0.75 grams in 1 liter C_2H_5OH) and titrated with Na_2CO_2 (2.409 grams per liter) till pink color persists 5 min. at 15–20°C. Schloessinger's formula, recalculated, is used, and a table given of CO_2 in H_2O in mgm. per liter.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Causes and Stoppage of a Typhoid Epidemic. J. FREUND AND V. ANDRISKA. Leit. f. Hyg., **92**: 311, 1923. Bull. mens. office internat. d'hyg. publique **15**: 1228, 1923. Miskolcz (Hungary), 60,000 population, had 292 cases typhoid during March–May 1922. Epidemiological check incriminated water, though its bacterial count ranged from 150 to 670 per cc., and neither Bact. typhosum nor Bact. coli could be found. Water was chlorinated and after 9 days, epidemic ceased.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Purification of the Waste Waters of Coke Plants. R. DURAND. L'Eau, **16**: 115 (October 15, 1923.) Fish killing in the Marne was charged to waste from coke plants, found to contain phenol, HCN, and H_2S. It was slightly toxic. Treatment with javel water was found to remove satisfactorily both H_2S and HCN.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Goiter and Lack of Iodine in Potable Water. CHEINISSE. La Press Medicale, **44**: 919, 1923. Bull. mens. office internat. d'hyg., publique, **15**: 1239, 1923. Articles of McClendon and Williams confirm work of Chatin in 1852.—*Jack J. Hinman, Jr.*, (*Courtesy Chem. Abst.*)

The Influence of Hydrogen Ion Concentration on the Dose of Alum and the Mechanism of the action of Alum in the Clarification of Natural Waters. NAN LAL BANERJI. Indian Journal of Medical Research, 11: 3, 695–718, January, 1924. Study of water of Hooghly river, supplying Calcutta, which does not agree with results of Morison who used the softer waters of Poona in his work (Indian J. Med. Res., 3: 4, 565, 1916) Banerji concludes: (1) Other factors, such as amount of suspended matter, size of particles, conc'n of electrolytes, etc. remaining constant, optimum dose of alum increases, as pH increases, and decreases, as pH decreases; (2) Total hardness plays important part in regulating dose; (3) Mechamism of the reaction may be divided into two parts: (a) Unhydrolysed $Al_2(SO_4)_3$; (b) Hydrolysed $Al_2(SO_4)_3$; made up of H_2SO_4 and Al (OH);. The positive Al ion from the unhydrolyzsed portion is most potent factor in clarification. Next comes the H ion, and last and least is the Al $(OH)_3$ sol; (4) Dose of alum can be decreased by preliminary addition of a cheap acid such as H_2SO_4. Dose of acid should be regulated so that pH will not be far from 7.0. Increase in dose of alum allows decrease in amount of acid. It is suggested that economy might be secured by treating mud from filters with acid, to dissolve $Al(OH)_3$, and using the acid solution to acidify alum solutions being applied to water.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Removal of Acid, Manganese, and Bacteria from Drinking Water and the Bacterial Purification of Swimming Pool Water. W. OLSZEWSKI. Berichte deut. Pharm. Gesellschaft, 33: 168–177, 1923; Wasser und Abwasser, 18: 337, 1923. Removal of aggressive H_2CO_3 is accomplished by aëration or $CaCO_3$. Hard water is best aërated. In removal of Mn by filtration through MnO_2, there must be a sufficient layer of fine MnO_2. Prior chlorination of water cannot be done if biological manganese removal is to be attempted. Recommends rapid sand filtration and Cl for bacterial removal. For pools chlorination is necessary in addn. to filtration. Uusally have 0.2 to 0.5 p.p.m. excess Cl. Dropping Cl dosage means quick falling off in the quality of the pool water.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Simple Method of Well Disinfection. RICHARD WINDISCH. Berliner tierärtzliche Wochenschrift, 39: 17, 189, 1923. Wasser und Abwasser, 18: 9, 266, September 8, 1923. Adds large dose of unslaked lime (several hundredweights) and pumps out well after 8 days, repeating every few days until taste is normal.—*Jack J. Hinman, Jr.*

Utilization and Protection of Springs. F. DIENERT. Annales d'hygiene publique, industrielle, et sociale, 1: 581, 1923. Bull. mensuel office internationale d'hygiene publique, 16: 105, Jan. 1924. Details the contant supervision exercised over spring water supplies of Paris. In fissured rocks, contamination may be carried as far as 10 to 15 km.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

The Campaign against Typhoid Fever in Belgium. DR. VAN BOEKEL. Bulletin mensuel office internationale d'hygiene publique, 16: 22–59, January, 1924. General review of the situation from many angles.—*Jack J. Hinman, Jr.*

Experiences with the Use of a Jewell Filter on River Water in the Tropics. G. KORTHOFF. Geneesk. Tijdschrift voor Nederlandsch Indie, 62: 359–362, Wasser und Abwasser, 18: 259, September 8, 1923. Filter was washed with raw water. Found that germ-free water was not obtained and that it was inadvisable to attempt to leave the operation to inexperienced help.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Water for the English Expedition in Palestine. ED. IMBEAUX. Rev. d'Hyg., 46: 125–135, February, 1924. Description of work undertaken by British Army. Largely details of construction.—*Jack J. Hinman, Jr.*

Filtration, Chlorination and Recirculation of Swimming Pool Water. DR. B. BURGER. Veröf. deut. Gesesellschaft für Völksbader, 7: 1922; Wasser und Abwasser, 18: 342, December, 1923. Rapid sand filters and Cl are used at Berlin-Neukölln swimming pools, and equipment operated 24 hrs. per day. After 18 days use, chlorides had risen from 60 to 88 p.p.m. Water, yellow at start, became clear and colorless. Odor of the bath was destroyed without Cl being noticeable.—*Jack J. Hinman, Jr.*

On the Living and Dead Suspended Matter of the Chlorinated Swimming Pool Water. J. WILELMHI. Verof. deut. Gesellschaft für Völksbader, 7: 1922; Wasser und Abwasser, 18: 342, December, 1923. The Berlin-Neukölln pool when containing 0.35 p.p.m. free Cl showed no green algae or other plants to be living. Amoebae were present, but other animal forms were limited to worms. The suspended material included hair, epithelial cells, etc. Preliminary baths are necessary.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Scale-Formation and Corrosion in Boilers. ALLAN A. POLLITT. Chem. Age (London), 7: 76–8, 1922. From Chem. Abst. 16: 3151, September 20, 1922. Effect of impurities in boiler feed water and mechanism of corrosive reactions responsible for deterioration of boiler tubes and plates discussed.—*R. E. Thompson.*

Investigation of Various Varnishes and Paints in Regard to their Rust-Preventive Properties. MAASS AND JUNK. Z. angew. Chem., 35: 353, 360–3, 1922. From Chem. Abst., 16: 321. September 20, 1922. Various substitutes for linseed oil such as cumarone resins, tar oils, phenol-aldehyde products, etc., are generally unsatisfactory. Tests were made on tar oil preparations and "Imprex" varnishes (manufactured by G. Ruth, Wandsbek) made from linseed oil with addition of inert colloidal thickening agent which effects a saving of up to 70 per cent of the oil. Boiled linseed oil showed greater permeability to water and less protection against rusting then the other oils: in other respect tar oil preparations were decidedly inferior. One of the Imprex varnishes had excellent elasticity, durability, and impermeability, and, on account of its high spreading rate, is very economical and serviceable for certain purposes.—*R. E. Thompson.*

Miscellaneous Exposure Tests. H. A. GARDNER. Paint Manfrs. Assoc. of U. S., Circ., 152: 282–313, 1922. From Chem. Abst., 16: 3216, September 20, 1922. Brush and spray coats showed equal durability on three years exposure. Examination of paints containing titanium oxide and exposed for 20 months, showed this pigment, in combination with zinc oxide and an inert other than whiting, to give good results. Paints exposed in Texas sulfur regions composed of titanium oxide, lithopone, zinc oxide and inerts were in very good conditions after 10 months, while those containing leaded zinc were badly discolored but regained their original whiteness when the sulfur plant was out of commission.—*R. E. Thompson.*

Forces of Adhesion in Solution. II. Coagulation of Coarse Suspensions. S. Wosnessensky. Kolloid-Z., 33: 32–4, 1923: cf. C. A., 17: 1572. From Chem. Abst., 17: 3437, November 10, 1923. Single electrolytes, with exception of calcium and barium hydroxide did not have coagulating effect on coarse suspensions of kaolin, alumina and antimony oxide. Marked coagulation occurs with simultaneous action of bivalent or trivalent metal salts and caustic alkalies, e.g., barium chloride and sodium hydroxide or aluminium chloride and sodium hydroxide. These materials form difficultly soluble hydroxides which are adsorbed on the surface of particles of suspension and cause coagulation by changing forces of adhesion and cohesion. Materials such as ammonium chloride and tartaric acid which hinder formation of hydroxides disturb the coagulation. The thickness of the adsorbed hydroxide is estimated to be of molecular dimensions.—*R. E. Thompson.*

The Limits of Hydrogen Ion Concentration as Determined by Electrometric Titrations in Water Solutions of Carbon Dioxide, Calcium Sulfate, and Calcium Carbonate. J. W. SHIPLEY AND I. R. MCHAFFIE. J. Soc. Chem. Ind., 42: 311–9 T, 1923. From Chem. Abst., 17: 3440, November 10, 1923. Data given on electrometric titration of calcium hydroxide and carbonate with sulfuric acid and carbon dioxide. The pH values of mixtures of calcium carbonate and sulfate and carbon dioxide varied from 9.38, value for saturated calcium carbonate, to 3.96, value for saturated carbon dioxide. With all three substances present the value remained practically constant at 5.11. In absence of calcium sulfate it did not fall below 6.56: hence calcium sulfate increases acidity of water containing calcium carbonate and carbon dioxide. In absence of calcium carbonate, pH value of saturated carbon dioxide was same whether calcium sulfate was present or not.—*R. E. Thompson.*

The Bicarbonate Equilibrium. J. W. SHIPLEY AND I. R. MCHAFFIE. J. Soc. Chem. Ind., 42: 319–20T; 321–6T, 1923. From Chem. Abst., 17: 3441, November 10, 1923. Hydrolysis of saturated calcium carbonate solution calculated to be 8 or 10 per cent. This is much lower than values obtained by previous investigators. Solubility products of calcium carbonate and hydroxide at 20° were found to be 1.15×10^{-8} and 0.64×10^{-5}, respectively. Constant for ionization of H_2CO_3 into H^+ and HCO_3^- was found to decrease with dilution; while that for ionization of HCO_3^- into H^+ and CO_3^{--} increases with dilution and the product $H^+ \times CO_3^{--}$ is independent of dilution. The

proportion of dissolved carbon dioxide which is present as carbonic acid varies directly as the dilution.—*R. E. Thompson.*

The Melting Point of Ice on the Absolute Temperature Scale. L. B. Smith and R. S. Taylor. J. Am. Chem. Soc., **45**: 2124–8, 1923. From Chem. Abst., **17**: 3444, November 10, 1923. Value of absolute temperature of melting ice from volume coefficient of N_2 is found to be 273.159° and from pressure coefficient 273.097°. Mean value obtained by using data of other gases including Joule-Thomsen coefficient is 273.13° ± 0.01°.—*R. E. Thompson.*

Composition of the Precipitate from Partially Alkalinized Alum Solutions. L. B. Miller. U. S. Public Health Reports, **38**: 1995–2004, 1923. From Chem. Abst., **17**: 3461, November 10, 1923. Varying amounts of sodium hydroxide were added to alum solutions 0.005 and 0.02 molar in aluminum, at room temperature and, to latter, at 100°. For additions of sodium hydroxide up to 2.5 molecules per molecule of aluminium at room temperature, composition of precipitate was constant and approximated Williamson's $5Al_2O_3 \cdot 3SO_3$. Increasing concentration of SO_4 ion over wide range, by addition of potassium sulfate or ammonium sulfate, or increasing aluminum concentration up to 0.1 molar had no effect on composition of precipitate formed at definite pH. The precipitate appears to consist of two components of nearly equal solubility. For 0.005 molar concentration greatest insolubility of precipitate was found at pH 6.7–7.0, at which point 2.75 molecules of sodium hydroxide have been added. On both sides of this, pH 5.4 and 8.5, are zones of great insolubility. Theriault and Clark's point of greatest flocculation, pH 5.5 (2.4 molecules of sodium hydroxide added), is point where precipitation first approaches completion and is in region where greatest SO_4 is found in precipitate. In Blum's method for aluminum determination it is esssential that SO_4 be absent or present in small amount. If present in large amount second precipitation from hydrochloric acid solution is necessary. Chloride is satisfactorily removed by ten minutes ignition over Meker burner.—*R. E. Thompson.*

The Purification of Water from Standpoint of Feeding Non-Corroding and Non Incrusting Water to Coolers. Alexandre. Chaleur et Industrie, **3**: 1853–8, 1922: Chimie et Industrie, **10**: 276, 1923. From Chem. Abst., **17**: 3556, November 10, 1923. Review and discussion of merits and demerits of various processes for purification of boiler feed water.—*R. E. Thompson.*

Studies on Salt Action. VIII. The influence of Calcium and Sodium Salts at Various Hydrogen-Ion Concentrations upon the Viability of Bacterium Coli. IX. The Additive and Antagonistic Effects of Sodium and Calcium Chlorides upon the Viability of Bacterium Coli. C. E. A. Winslow and I. S. Falk. J. Bact., **8**: 215–44, 1923; cf. C. A., **17**: 3052. From Chem. Abst., **17**: 3522, November 10, 1923. pH 6.0 most favorable to viability. A 0.0145 molar sodium chloride solution and 0.00145 molar solution of calcium chloride were favorable to viability. Sodium chloride solutions of over 0.725 molar strength and calcium chloride solutions of over 0.435 molar strength were toxic at all reactions.—*R. E. Thompson.*

Nitrogen and other Substances in Rain and Snow. J. H. WOEHLK. Chem. News, 127: 30, 1923; cf. C. A., 16: 3993. From Chem. Abst., 17: 3558. November 10, 1923. Details of analysis of 12 snows and 29 rains at Mount Vernon, Iowa (October 1, 1922,–June 1, 1923) given. Parts per million: chlorine varied from 3.54 to 28.1: nitrogen averaged 0.896 and was quite constant: average free ammonia was 0.34, albuminoid ammonia 0.264, nitrogen as nitrates 0.346, as nitrites 0.397, and sulfur as SO_3 0.147.—*R. E. Thompson.*

The Mineral Waters of Aix-les-Bains and of Marlioz (Savoie). D'ARSONVAL, F. BORDAS AND TOUPLAIN. Ann. fals. 16: 268–86, 1923. From Chem. Abst., 17: 3557, November 10, 1923. Two springs at Aix-les-Bains (so-called "alum" and sulfur springs) and three springs at Marlioz (Esculape, Bonjean, Adelaide) are described. The composition, in grains per gal., of "alum," "sulfur," Esculape and Bonjean springs, respectively, are: iron, traces; aluminium, 0.0014, 0.0018, 0.00402, 0.00461; manganese, trace, trace, none, none; calcium, 0.0924, 0.1112, 0.11696, 0.09411; magnesium, 0.020, 0.0222, 0.014, 0.0137; potassium, 0.0028, 0.0020, 0.00635, 0.00804; sodium, 0.025, 0.0248, 0.0624, 0.0552; chlorine, 0.0199, 0.0248, 0.041, 0.040; bromine, none, none, 0.00001, 0.00002; iodine, none; silica, 0.0249, 0.0333, 0.0367, 0.04048; SO_4, 0.130, 0.1677, 0.1836, 0.1775; sulfur, none; S_2O_3, none; phosphoric acid, traces; CO_3, 0.1901, 0.163, 0.125, 0.115; arsenious acid, none; nitrates, none; nitrites, none.—*R. E. Thompson.*

Boron as a Specific Constituent of Certain Mineral Waters. F. BORDAS AND F. TOUPLAIN. Ann. fals., 16: 356–60, 1923. From Chem. Abst., 17: 3557, November 10, 1923. Flame and turmeric paper methods of detecting boron described. The sensitiveness of the former is approximately 0.03 milligrams of boron. It is suggested that boric acid be used instead of fluorescein in tracing subterranean course of springs.—*R. E. Thompson.*

Production of Alkalinity by Bacteria as Registered by Different Indicators. J. A. REDDIE. J. Soc. Chem. Ind., 42: 326–32T, 1923. From Chem. Abst., 17: 3558, November 10, 1923. Filtration usually reduces alkalinity of sewage, which is normally in neighborhood of 300 p.p.m. At Bradford the reverse is true. The increase was found to be independent of type of filter used and is attributed to the high protein content of the Bradford sewage.—*R. E. Thompson.*

The Disposal of End Liquor at the Beinerode Potash Works. ERNST FULDA. Kali, 17: 146–50, 1923. From Chem. Abst., 17: 3558, November 10, 1923. End liquor is pumped into abandoned and flooded shaft in mountain composed largely of conglomerate, segmented gypsum. Estimated that this deposit will absorb at rate of 120,000 cu. m. per year, end liquor produced by works for 390 years.—*R. E. Thompson.*

Aluminum Hydroxide. I. Hydrates and Hydrogels. RICHARD WILLSTATTER AND HEINRICH KRAUT. Ber., 56B: 149–62, 1923. From Chem. Abst., 17: 3513, November 10, 1923. Alumina prepared in different ways, details of

which are given, was used to determine whether cause of variation in activity as adsorbent is formation of chemical compounds, and whether adsorption activity and chemical properties are so related as to differentiate kinds of alumina. When invertase prepared from yeast was used, adsorption value of aluminum hydroxide was increased many times by dilution. There seemed to be no simple relation between colloidal properties and adsorption activity of aluminum hydroxide gels.—*R. E. Thompson.*

The Present Status of Water Purification in Iowa. JACK J. HINMAN, JR. Proceedings, Thirty-fifth Annual Meeting, Iowa Engineering Society, Des Moines, January 23–6, 1923. Water purification in Iowa reviewed and methods of control employed by State Department of Health outlined. There are approximately 500 water plants in the state, of which 52 attempt complete purification. Forty-eight chlorinate. Higher percentage of good samples obtained from treatment plants than from any other source of supply, public or private. Of public supplies, percentage of good samples is least from springs and shallow wells, while deep wells are intermediate between these and treated waters. Charts included showing location of purification plants, growth of purification since 1890, and conditions of water samples classified by sources. Data on essential features and purification effected at 23 plants given.—*R. E. Thompson.*

Cardiff Water Works Undertaking. N. J. PETERS, H. W. B. COTTRILL AND B. SANTO CRIMP. Municipal Engineering, **72**: 702, 1923. Brief outline of papers presented at Public Works Conference, London, Eng. System of rough filtration will be installed to prevent incrustation and growth in conduit from impounding reservoirs.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

The Adsorption of Organic and Inorganic Colloidal Electrolytes. M. A. RAKUZIN. J. Russ. Phys. Chem. Soc., **53**: I, 357–68, 1921. From Chem. Abst., **17**: 3635, November 20, 1923. Alumina irreversibly adsorbed 44 per cent of gum arabic from solution in 48 hours. Colloidal solutions of potassium silicate and sodium fluorosilicate were reversibly adsorbed, being partly recoverable by boiling with water.—*R. E. Thompson.*

An Improved Methyl Orange. J. MOIR. J. S. African Chem. Inst., **6**: 69–70. 1923. From Chem. Abst., **17**: 3652, November 20, 1923. New indicator, *p*-sulfo-*o*-methoxybenzeneazodimethyl-α-naphthylamine, described. Changes from deep yellow to red-purple in artificial light and from orange to blue-violet in daylight. pH range is from 4.9 to 3.5. With tap water it showed alkalinity of 13.5 CaO compared with 14 with methyl orange. With greater alkalinities, the values were same. Is more satisfactory than methyl orange in artificial light.—*R. E. Thompson.*

An Apparatus for Electrometric Titrations. A. J. PELLING. J. S. African Chem. Inst., **6**: 40–8, 1923. From Chem. Abst., **17**: 3630, November 20, 1923. Satisfactory form of apparatus for H-ion titrations. Use in titrating mine waters described.—*R. E. Thompson.*

The Influence of Alcohol on the Sensitiveness of Dye Indicators. I. M. KOLTHOFF. Rec. Trav. chim., 42: 251–75, 1923. From Chem. Abst., 17: 3652, November 20, 1923. Eighteen indicators were investigated. Concluded that indicators that act like acids become more sensitive to H-ions in presence of ethyl alcohol, regardless of whether indicator is acid- or alkali-sensitive.—*R. E. Thompson.*

The Use of the Quinhydrone Electrode in Place of the Hydrogen Electrode in Potentiometric Acidity Determinations. I. M. KOLTHOFF. Rec. Trav. chim., 42: 186–98, 1923. From Chem. Abst., 17: 3654, November 20, 1923. Quinhydrone electrode of Granger discussed. Advantages over hydrogen electrode are: more easily prepared; potential quickly established; may be used in solutions in which hydrogen electrode is useless, such as solutions of metallic salts, alkaloid salts, etc.—*R. E. Thompson.*

Volumetric Method for Determination of Magnesium. M. BULLI AND L. FERNANDES. Ann. chim. applicata, 13: 44–5, 1923. From Chem. Abst. 17: 3655, November 20, 1923. Precipitation of Mg $(NH_4)_2$ $Fe(CN)_6$ from solutions containing Mg^{++} and $Fe(CN)_6^{----}$ in presence of ammonium salts utilized for determining magnesium volumetrically.—*R. E. Thompson.*

Colorimetric Determination of H-Ion Concentration by the Method of Michaelis with One Color Indicators, with Inorganic Solutions for Color Comparison. I. M. KOLTHOFF. Pharm. Weekblad, 60: 949–66, 1923. From Chem. Abst., 17: 3654, November 20, 1923. Optimum pH ranges found were: 2, 6-dinitrophenol, 2.0–4.0; 2, 4-dinitrophenol, 2.6–4.4; 2, 5-dinitrolphenol, 4.0–5.8; p-nitrophenol, 5.6–7.6; m-nitrophenol, 6.8–8.6; phenolphthalein, 8.0–10.0; salicyl yellow, 10.0–12.0.—*R. E. Thompson.*

Volumetric Method for the Determination of Potassium. M. BULLI AND L. FERNANDES. Ann. chem. applicata, 13: 46–8, 1923. From Chem. Abst., 17: 3655, November 20, 1923. The complex compound $K_2Pb(Co(NO_2)_6$ (cf. CUTTICA, C. A. 17: 3000) used for precipitating and determining potassium indirectly by volumetric method.—*R. E. Thompson.*

Electrolytic Protection of Condenser Tubes. A. B. Technique moderne, 15: 567–8, 1923. From Chem. Abst., 17: 3671, November 20, 1923. Discussion of cause of corrosion of marine engine condensers and its prevention or retardation by passage of electric current. For new condenser tubes and corrosive water it is advisable to use high amperage for few days until a thin film of calcium carbonate (few tenths of mm.) is formed and then reduced to about 3 amps.—*R. E. Thompson.*

Water Purification. W. F. LANGELIER. U. S. (Patent) 1,465,137, August 14. From Chem. Abst., 17: 3734, November 20, 1923. Water or sewage to be purified is treated with soluble aluminium salt such as aluminium sulfate and with sufficient hydrochloric, sulfuric or other acid to give pH which will assist coagulation and sedimentation.—*R. E. Thompson.*

First Experimental Report to the Atmospheric Corrosion Research Committee of the British Non-Ferrous Metals Research Association. W. H. J. VERNON, Pp. 62 (Presented to Faraday Society, December 17, 1923.) Chem. Ind., 43: 13, 339, March 28, 1924. Work was carried out at Royal School of Mines, South Kensington. Metal plates, measuring 10 cm. square with either polished or matte (emeried) surfaces, were exposed to four different types of atmosphere: (1) always unsaturated with water vapour; (2) moisture content from time to time reaching saturation value; (3) containing gas combustion products from cooking and lighting; (4) external air on roof of Royal School. Curves showing relation between weight increment (W) and time (t) have been plotted in many cases. Three types of curves may be distinguished: (1) those in which rate of increase falls off with time, as surface-film becomes thicker and obstructs access of tarnishing agent to unchanged metal beneath; (2) those in which rate of increase does not alter with time. (3) those in which rate of attack increases with time. Iron specimens kept in tank-room rusted at a rate which increased as rust accumulated.—*A. M. Buswell.*

Effect of Excess Air on Flue Temperatures and on Efficiency.. A. K. BAK. Power, 59: 17, 635, April 22, 1924. Air quantity has important bearing on boiler losses and efficiency. Variation in quantity has direct effect upon mass of flue gas discharged and also gives rise to changes in flue gas temperature. Results of tests at Conners Creek Plant of Detroit Edison Co., establish relation between excess air and stack gas temperature for that particular boiler and setting.—*Aug. G. Nolte.*

Relative Merits of Different Types of Motor Bearings. F. E. BOYD. Power, 59: 17, 641, April 22, 1924. Relative merits of ball, roller, and sleeve bearings, from user's viewpoint, are discussed.—*Aug. G Nolte.*

Development of the 12000 Horsepower Nürnberg Diesel. W. LAUDELIN. Power, 59: 17, 642, April 22, 1924.—*Aug. G. Nolte.*

Water Treatment at Cahokia. E. H. TENNEY. Power, 59: 17, 647, April 22, 1924. The various uses for which water was required in operation of Cahokia Plant of Union Electric Light and Power Co., on east bank of Mississippi River, opposite St. Louis, called for design of a treating system to purify the raw river water. Author illustrates and describes the purification system and gives characteristics of the raw water.—*Aug. G. Nolte.*

Some Methods of Storing Coal. Power, 59: 3, 96, January 15, 1924. Several low-priced systems for storing coal mechanically are discussed.—*Aug. F. Nolte.*

Maintaining Quality of Steam Turbine Oils in Service. C. H. BROMLEY. Power, 59: 4, 125, January 22, 1924. Discusses principal factors in recent developments of information and equipment as related to maintaining quality of lubricating oils in use in steam turbines. Effects of oxidation, heat and air on oil. Several systems for purification of oil illustrated and described.—*Aug. F. Nolte.*

The Locomotive Crane as a Coal-Storage Machine. Power, 59: 4, 133, January 22, 1924.—*Aug. F. Nolte.*

Coal-Storage Systems for Large Plants. Power, 59: 5, 172, January 29, 1924. Various systems for storage of coal are illustrated and described.—*Aug. G. Nolte.*

Boiler-House Efficiency. J. T. BEARD, 2ND. Power, 59: 5, 168, January 29, 1924. Analyzes factors entering into combined, or over-all, efficiency of a boiler; points out how they are related to one another; shows how they are influenced by design of the equipment; and indicates what steps may be taken to increase efficiency by prevention of excessive losses.—*Aug. G. Nolte.*

Application of Various Types of Coal-Handling Equipment. G. E. TITCOMB. Power, 59: 5, 189, January 29, 1924. Abstract of a paper presented before Metropolitan Section, A. S. M. E., of New York City on January 22, 1924.—*Aug. F. Nolte.*

Accelerating the Softening of Water. MASCHINENBAU-A.-G. BALCKE. G. P. 381,042, 8.5.21. Chem. Ind., 43: 20, B 398, May 16, 1924. High velocity is imparted to water after it has been treated with softening agents, and is subsequently reduced by means of baffles or the like; whereby separation of precipitated material is accelerated. Apparatus comprises turbine-like device with baffles disposed around its periphery and lower part, enclosed in a receptacle, open at the bottom, mounted in a sludge-separating chamber covered at the top by a filter. The raw water is introduced through pipe passing downwards through the filter.—*A. M. Buswell.*

Hydrotitrimetric Analysis. (Determination of Hardness of Water.) N. TARUGI AND G. GASPERINI. Boll. Chim. Farm., 1924, 63, 33–38, 65–70. Chem. Ind., 43: 18, B 350., May 2, 1924. One of principal causes of inaccuracies attending use of Boudron and Boudet's modification of Clark's method for determining hardness of water lies in nature of the solution used, this consisting of an aqueous alcoholic solution of a mixture of sodium oleate, palmitate, and stearate, which do not always behave similarly towards alkaline-earth salts. The use of stearate solution being inconvenient, owing to the relatively low solubilities of both sodium and potassium stearates, and consequent tendency of solutions to form deposits in cold weather, the use of potassium palmitate solution is recommended for determining hardness of waters.—*A. M. Buswell.*

Separation of Impurities from the Wash-Water of Filters. B. BRAMWELL. E. P. 211, 307, 11. 1. 23. Chem. Ind., 43: 18, B 351, May 2, 1924. The wash water is delivered to settling tank with V-shaped bottom or to a pair of these tanks, communicating at farther end. The deposited solids are raised by travelling elevator of bucket type and discharged into narrow shallow sludge channel alongside. Effluent is filtered and used again for washing of filtering material.—*A. M. Buswell.*

Manufacture of Water Softening Materials. S. V. H. Lassen and United Water Softners, Ltd. E. P. 211,240, 14.2.23. Chem. Ind., 43: 18, B. 351, May 2, 1924. Artificial zeolites and similar base-exchanging compounds are rendered resistant to disintegration and to solvent action of acid waters, by a process of thorough drying followed by hydration. The precipitates, prepared by interaction of suitable salts, are slowly dried at 80°–100° until no further loss in weight occurs. While in form of comparatively large lumps, material is then subjected for some hours to current of mixture of air and steam. Proportion of steam to air is small at first and is gradually increased as hydration proceeds. Water-softening materials prepared by fusion processes may be similarly hydrated.—*A. M. Buswell.*

Allen Salt Velocity Method of Measuring the Flow of Water. Power, 59: 18, 683, April 29, 1924. Article is based on paper by C. M. Allen and E. A. Taylor, presented at annual meeting of American Society of Mechanical Engineers, December 3 to 6, 1923. In measuring flow of extremely large quantities of water, such as in hydro-electric plants, it is general practice to measure rate of flow through penstock or canal of known cross-section and calculate volume therefrom. Allen salt-velocity method is simple and accurate way of measuring rate of flow, based on facts that salt in solution increases the electrical conductivity of water, and that if a quantity of salt solution is introduced into fresh water flowing through a pipe, although solution may tend to spread out and mix with water, its point of greatest density will retain practically a fixed relation to rate of flow in pipe. Suppose for example that two sets of electrodes are placed in a pipe line a measured distance apart, and that to each set is connected a source of electric current with an ammeter in circuit; in fresh water, no current will flow and meter will indicate zero. If charge of salt solution is introduced on upstream side of upstream set of electrodes, as it is carried down with current it comes in contact with upstream electrodes: needle of the ammeter is then deflected gradually from zero to a maximum and back to zero again. Later, down-stream electrodes, similar deflections of ammeter on that set will occur. Difference in time between the two maximum readings will be found to represent very closely correct period of flow between the two sets of electrodes. Article describes experimental work in connection with development of the method and shows how a quantity of salt solution may be expected to act, when carried along by a current of water.—*Aug. G. Nolte.*

Finding the Cost of Exhaust as Compared to Live Steam. C. E. Colburn. Power, 59: 20,759, May 13, 1924.—*Aug. G. Nolte.*

Construction of Boiler Settings in Devon Station. Power, 59: 20, 763, May 13, 1924. Furnace walls constructed entirely of firebrick. Arches built in walls to relieve loading on brick. Expansion joints filled with asbestos fiber divide walls into vertical sections and allow for horizontal expansion. Vertical expansion provided for by expansion joints under the relieving arches and at lower tube line. No heat-insulating bricks used below lower tube line. Illustrated.—*Aug. G. Nolte.*

How External Air Cooling Increases the Effectiveness of Condenser-Tube Surface. P. BANCEL. Power, 59: 20, 769, May 13, 1924.—*Aug. G. Nolte.*

Computing Guaranteed Stoker Efficiency, H. F. GAUSS. Power, 59: 21, 813, May 20, 1924; also Power, 59: 22,858, May 27, 1924. Discusses factors entering into computation of stoker efficiency. Typical examples and convenient charts to facilitate computations are given.—*Aug. G. Nolte.*

Application of Motors to Power House Auxiliary Drives. H. L. SMITH. Power, 59: 21, 817, May 20, 1924. Types of drives available for various auxiliaries are considered. Reliability of service and simplicity and flexibility of operation should govern the choice.—*Aug. G. Nolte.*

The Testing of Boiler Plates. DR. C. L. HUSTON. Power, 59: 21, 821, May 20, 1924.—*Aug. G. Nolte.*

Relative Cost of Water and Steam Power. Power, 59: 21, 827, May 20, 1924. Instructive comparisons between costs of water and of steam power, in paper by Halford Erickson, vice-president of Byllesby Engineering and Management Corporation, before Wisconsin Utilities Association. Construction costs and fixed charges for water plant are, as a rule, twice as great as for steam plant, and overbalance the smaller operating expense. Steam plant has greater reserve capacity and is in position to render better and safer service.—*Aug. G. Nolte.*

The Diagnosis of Diesel-Engine Defects from Indicator Diagrams. R. C. MELROSE. Power, 59: 23,898, June 3, 1924. In actual practice, conditions as shown by theoretical diagram (illustrated) are not obtained; because, (1) the water, circulating in jacket, cylinder head, and piston absorb heat during compression and expansion; (2) particles of oil are still burning after fuel valve is closed; (3) the combination of oxygen, carbon and hydrogen does not remain constant; (4) mechanical defects; such as leaking piston rings, exhaust valves, air inlet valves, fuel valves, air starting valves, etc.; (5) effect of high piston speed on volumetric and scavenging efficiencies. Specific defects are discussed and their presence illustrated by indicator diagrams.—*Aug. G. Nolte.*

Pulverized-Fuel Systems. A. L. COLE. Power, 59: 23, 900, June 3, 1924, and Power, 59: 24,940, June 10, 1924. Series of articles describes different types of equipment now in general use for drying, pulverizing, transporting, and burning coal in pulverized form. Some present day types and methods are presented and illustrated.—*Aug. G. Nolte.*

Piping Materials, Valves and Gaskets for High Pressures and Temperatures. J. D. MORGAN. Power, 59: 23, 907, June 3, 1924. Data taken from practice. —*Aug. G. Nolte.*

Quantitative Expression of the "Aggressivity" of a Water and the Applicability of De-Acidification Processes. A. MUNDLEIN. Gas-u. Wasserfach, 1924. 67, 161–163, 178–180: Chem. Ind., 43: 22, B 440, May 30, 1924. Of the free carbon dioxide present in water, a portion serves to hold the bicarbonates in solution, and is termed the natural ("zugehörige") carbon dioxide; the remainder forms the "aggressive" carbon dioxide. Free carbon dioxide can be removed by a current of air. The natural carbon dioxide dissolves iron, whilst aggressive carbon dioxide dissolves both iron and calcium carbonate. Graphs show the relation between hardness and "natural" and total free carbon dioxide and relative rates of solution of iron (curves for h = 0.25, h=0.5, etc.) and of calcium carbonate (curves 0, 4, 30, 95, and 180). As aggressivity depends upon hydrogen-ion concentration, water with a given total free carbon dioxide content will have an aggressivity dependent upon its hardness; from which it follows that the choice between mechanical and chemical treatment to reduce the aggressivity of a given water will be determined by its hardness and that occasionally both treatments are necessary.—*A. M. Buswell.*

Method for Purifying Water (Softening, and Removing Dissolved Salts). E. MAYER AND R. SCHON. Oesterr. Chem-Ztg., 27: 46–47, 1924: Chem. Ind., 43: 22, B 441, May 30, 1924.—*A. M. Buswell.*

The Construction and Maintenance of Water Facilities at Stock Yards. ANON. Railway Engineering and Maintenance, 19: 457, 1923. Com. report to Am. Ry. Bridge and Bldg. Assoc. gives detailed recommended practice in supplying water to railway stock yards.—*R. C. Bardwell.*

Pumping Water From a Stream With a Sixty Foot Stage Variation. ROBERT HERZOG. Railway Eng. and Maintenance, 19: 391, 1923. Detailed plans are shown and explained covering construction of concrete dry well 70 feet deep by Great Northern R. R. at Wenatchie, Wash. Duplicate units consisting of 40 h.p. electric motors direct connected to 4 inches single stage horizontal centrifugal pumps are located in bottom of well on practical low water level. Starting and stopping of pumps is automatically controlled.—*R. C. Bardwell.*

Southern Pacific Completes Million Gallon Pumping Plant. ANON. Railway Eng. and Maintenance, 20: 105, 1924. The Southern Pacific R. R. installed two wells 870 feet deep at El Paso, Texas, from which water is pumped by air lift consisting of two 200 h.p. oil engines with 1214 cubic feet per minute compressors. Each well delivers 750 g.p.m. and installation is equipped with latest developments in air lift pumping. Photographs and general layout plan are given.—*R. C. Bardwell.*

Burlington Builds 900,000,000 gallon Reservoir. ANON. Railway Eng. and Maintenance, 19: 481, 1923. C. B. & Q. RR. installed earth dam with creosoted plank core, 700 feet long by maximum height 48 feet, near Galesburg, Ill., impounding 900,000,000 gallons water. Pumping units consist of three electrically driven triplex pumps each delivering 750 g.p.m. through six miles

of pipe line to terminal roundhouse. General plans and photographs are given.—*R. C. Bardwell.*

Construction of Gravel Wall Wells Solves Water Supply Problem. C. R. KNOWLES. Railway Eng. and Maintenance, **20**: 143, 1923. The Illinois Central RR. has completed two gravel wall wells 26 inches diameter by 147 feet deep at Paxton, Illinois, which deliver separately 340 g.p.m. and together 530 g.p.m. Pumps are vertical centrifugal electric driven. General description given of installation and results.—*R. C. Bardwell.*

The Use of Lead as Compared with Substitutes for Joints in Cast Iron Pipe. Com. report, A. R. E. A. Bulletin, **261**: 178, 1924. Progress report.—*R. C. Bardwell.*

Use of Treated Wood for Water Tanks. Com. report, A. R. E. A. Bulletin, **261**: 185, 1924. Creosoted yellow pine tanks have been found to give satisfactory service for water storage at less cost than untreated wood tanks of high grade lumber.—*R. C. Bardwell.*

Automatic Control of Electrically Operated Pumps. Com. report, A. R. E. A. Bulletin, **261**: 174, 1924. General description and principles of automatic starters.—*R. C. Bardwell.*

Publicity Campaign That Helped Gain Public Support. CLAUDE M. CHAPLIN. Fire & Water Eng., **74**: 845, October 17, 1923. Describes and illustrates advertisements of East Bay Water Co., Oakland, Cal., in daily papers, of which about 150 have been published. Fullest coöperation is given daily press when information concerning company is desired. Through authorized channels, company submits to all publications, with circulation in territory it serves, interesting news stories regarding operation, development work, improvements, maintenance and planning for the future.—*Geo. C. Bunker.*

Problems That Confront the Private Water Company. W. W. COLLEDGE. Fire & Water Eng., **74**: 895, October 24, 1923. Address before Pittsburgh (Penna.) Chapter National Association of Cost Accountants. In case of water utility company, in order that it may pay fair return on investment, it is not the amount of money it can charge for its product, because that is already fixed, but the amount of money it can save in operating expenses that is to be considered. Unless careful accounting is used and correct management applied, water company game will prove a game of charity so far as stockholders are concerned.—*Geo. C. Bunker.*

Water Earnings Take Care of Improvements and Expenses. D. C. SPENCER. Fire & Water Eng., **74**: 896, October 24, 1923. Brief notes on municipal water works of Spartanburg, S. C. Water works acquired in 1908 by purchase; today there are 65 miles of mains, 325 hydrants, and 4000 consumers. Pumping equipment consists of two condensing steam pumps of 2 and 3 million gallons capacity, respectively, and of two direct connected motor driven pumps, each

of two million gallons capacity. Filter plant contains 8 units, each of 500,000 gallons capacity, with clear water well of 750,000 gallons capacity, and coagulating basin of 3,000,000 gallons. Raw water storage on Chinquepin Creek has capacity of 6,000,000 gallons. Statement is made that during period of municipal ownership, operation has been self-sustaining and earnings have provided for increase and expansion.—*Geo. C. Bunker.*

Eliminating Water Hammer from a Pressure Regulating Valve. SYDNEY L. RUGGLES. Fire & Water Eng., 74: 947, October 31, 1923. Description of changes made in float and lever attached to 8 inch regulating valve of balanced type which works in pressure reducing chamber under pressure head of 272 feet on one side and 3 feet on other and is connected to pipe line 3 miles long. Changes eliminated water hammer in pipe line and resulting leaks from blown joints, which amounted to as many as 75 in some seasons and occupied repair gang from two weeks to a month each spring, recaulking joints. Illus.—*Geo. C. Bunker.*

Checking up on the Water Works Personnel. EDWARD F. FREY. Fire & Water Eng., 74: 951, October 31, 1923. Various forms used in keeping records and information concerning personnel of the Department of Water Supply of Detroit, Mich. Illus.—*Geo. C. Bunker.*

How Water Works are Graded as to Fire-Fighting Capacity. HARRY J. J. CORCORAN. Fire & Water Eng., 74: 991, November 7, 1923. In Iowa, National Board of Fire Underwriters' Standard Grading Schedule is used to grade system in connection with public fire department. The rules of National Board of Fire Underwriters and Central Actuarial Bureau are used in grading value of service for supply to privately owned automatic sprinkler equipments. Water system is examined on three points; adequacy, reliability, and pressures; 32 items are considered independently and sum of the individual charges determines relative class of the system. Under adequacy, normal ability of works to maintain domestic consumption demand and fire flow is considered. In arriving at reliability of system, each step, or operation, necessary in delivering water from source to hydrants is treated separately. In towns and cities larger than 2500 population, supply should be sufficient to maintain fire flow for 10 hours in addition to domestic consumption. Measurement is made on ability of system to deliver fire flow at any pressure down to 20 pounds, this being minimum pressure at which supply is of value for fire streams. Ability to deliver water at pressures sufficient for direct hydrant streams is credited to offset lack of fire department pumping engine capacity; for direct hydrant streams 75 pounds residual pressure at hydrant during flow is necessary for 4-story buildings, 60 pounds is satisfactory for 3-story buildings, and 50 pounds for 2-story buildings and in residence districts. Six-inch is mimimum size pipe for hydrant supply and it should be well cross-connected. Gate valves are very necessary to localize effect of a break; spacing in high value districts should not exceed 600 feet; in other districts, 900 feet. With direct hydrant streams and 3000 gallons per minute required, one hydrant should be installed for each 70,000 square feet; with engine streams and same

quantity, one hydrant for each 100,000 square feet is satisfactory. Hydrants should be able to deliver 600 gallons per minute with a loss of not more than 2½ pounds in hydrant, and total loss of not more than 5 pounds between street main and outlet. Use of public water supplies through privately installed sprinkler systems is on increase. These systems provide most effective fire protection yet developed, and give property so equipped greatly reduced fire insurance rate. Water superintendents should actively encourage their installation. Reports of 28,560 fires in buildings so protected show that 20,234, or 84 per cent, were extinguished with ten or less sprinkler heads opening, or about 300 gallons per minute maximum. Only about 5 per cent required more than 1000 gallons per minute. Value of sprinkler system is entirely dependent upon reliable and adequate water supply. A public supply, to be satisfactory as primary source, must be able to maintain 12 pounds pressure on top line of sprinklers while 500 gallons per minute are flowing from nearest street hydrant. No pipe smaller than 6-inch is of value and in many cases larger pipe is needed.—*Geo. C. Bunker.*

Fuller Reports Great Progress in Water Works Field. GEORGE W. FULLER. Fire & Water Eng., **74**: 995, November 7, 1923. Progress report of committee on water supply and purification before Sanitary Eng. Section of A. P. H. Assoc. Following subjects are briefly discussed: New projects for water supply; Activity in building of filters, Iodine for combating endemic goitre; Working knowledge of superchlorination and dechlorination; An important legal decision; Corrosive action of water on pipe; Modification of United States Public Health standard; and Adoption of Uniform program in methods of testing water.—*Geo. C. Bunker.*

Water Company Presents Fire Department with Pumper. Fire & Water Eng., **74**: 997, November 7, 1923. Shelby Water Co., Shelby, Ohio, presented to city a triple combination fire pumper, in order to be relieved from necessity of boosting pressure every time fire occurs.—*Geo. C. Bunker.*

The Covered Reservoir and Its Advantages. GEO. C. BUNKER AND A. G. NOLTE. Fire & Water Eng., **74**: 1043, November 14, 1923. There is no doubt that present day tendency of water works practice is strongly toward covering of new service reservoirs, in which either ground or filtered waters are to be stored, at time they are built; while old uncovered reservoirs are gradually being covered after misdirected influence of amateur water works men, present in every community, has been overcome by practical demonstrations of what it means to interrupt water service of reservoir by frequent cleanings for removing growths of algae. Six very good reasons may be given for covering of service reservoir at time of construction; namely: (1) To maintain water supply in same condition of purity in which it leaves purification plant or ground, by (*a*) preventing entrance of dust, bird droppings, leaves, soot, and other foreign matter, and (*b*) preventing growth of algae. (2) To eliminate frequent cleanings of reservoir, which means that maximum storage capacity of system is always available in case of shutdown of purification plant or pump station. (3) To lessen danger of pollution of reservoir by gang engaged

in cleaning, or by trespassers. (4) To prevent loss by evaporation and to maintain water at uniform temperature. (5) To effect saving in cost of roof which, sooner or later, must be constructed, because it can be built at minimum cost and with no interruptions to water service. (6) Because an uncovered reservoir has no place in a well designed water supply system according to collective expression of engineering judgment. Illus. Cf. this J. 11:3742.—*Geo. C. Bunker.*

Installing Blind Water Services Before Paving. A. P. LOVELL. Fire & Water Eng., 74: 1047, November 14, 1923. In San Diego, Cal., ¾-inch lead service pipes are installed on every vacant 50-foot lot and at same time, half inch hole is drilled in curb, directly over service cock, filled with lead and stamped with letter W, so that pipe may be located later on without any trouble. Author considers it advisable to install sealed services previous to new paving, when we can be fairly well assured that it will be unnecessary to cut into new pavement within reasonable length of time. If cast-iron mains are laid with cement joints, and services in lead, many years should elapse before cutting pavement will be necessary. Author's statements concerning dangers of lead poisoning are easily open to misconstruction.—*Geo. C. Bunker.*

Selecting Pumps to Replace Obsolete Types. FRANK A. MAZZUR. Fire & Water Eng., 74: 1095, November 21, 1923. In making comparisons of various types of apparatus, author has based figures on units of about 3,000,000 gallons capacity in 24 hours, and has considered only plant having good boiler equipment, etc. Types considered are: (1) Steam driven: crank and fly wheel plunger pump; turbine driven centrifugal. (2) Electricaliy driven; horizontal plunger pump; centrifugal. (3) Oil engine; horizontal plunger pump. Comparison of the operating costs is given for three periods of pumping; 8, 16, and 24 hours per day. Illus.—*Geo. C. Bunker.*

Rainfall and the Recent Water Shortage. WALDO S. COULTER. Fire & Water Eng., 74: 1135, November 28, 1923. Diagram shows cumulative precipitation at Central Park station from December 1, 1922 to October 31, 1923; cumulative curve, representing average for 54 years at same station; cumulative precipitation for 1881 at Philadelphia; and cumulative precipitation on catchment area on Rockaway river above Boonton during 1918. The precipitation by months, for times and places covered by above curves, is shown at bottom of diagram. It is the widespread area affected and the increasing number of supply works operating with limited margin that have made the 1923 drought so disastrous at time of writing.—*Geo. C. Bunker.*

What a Change from Flat Rates to Meter Did for One Town. W. R. DAVIS. Fire & Water Eng., 74: 1187, December 5, 1923. In Clifton, Arizona, a change was made from flat rate system to meter system in order to prevent expenditure of approximately $80,000 for pumps, mains, new well, etc. Saving in water since meter system has been operative amounts to close upon 50 per cent of quantity furnished the domestic consumer. Cost of change was

$9,000. Tables show amounts of water used by average family in various cities in Arizona.—*Geo. C. Bunker.*

Measuring Large Flows with the Vee-Notch Weir. F. JOHNSTON-TAYLOR. Fire & Water Eng., 74: 1195, December 5, 1923. Description of recorder and integrator for use with this type of weir, both for large and small flows of water. Illus.—*Geo. C. Bunker.*

The Effect of Pressure upon Water Consumption. HUBERT P. MATTE AND JAMES O. G. GIBBONS. Fire & Water Eng., 74: 1231, December 12, 1923. Writers discuss possibility of converting all rates of consumption to their equivalent at some standard pressure, with sufficient degree of accuracy to enable intelligent comparison to be made between different reports of per capita consumption, particularly with view to disclosing cases of excessive leakage and mis-use of water. Assumption is made that water flowing varies as square root of pressure. Venturi chart shows actual water consumption at 45 pounds pressure and equivalent theoretical consumption at 20 pounds.—*Geo. C. Bunker.*

Proposed Water System of New City of Longview. Fire & Water Eng., 74: 1233, December 12, 1923. Description of water system contemplated for new industrial city of Longview in southwestern part of Washington. Present water supply is taken from deep wells and is large enough to take care of 15,000 people. For larger supply it is proposed to build dam across north branch of Goble creek and form reservoir which will have capacity of 400 million gallons an amount sufficient for 45 days' supply for 50,000 people. At foot of mountain, four miles distant from Longview, it is planned to build distributing reservoir of 25 million gallons capacity from which water will be carried through 24-inch cast iron pipe line to two reservoirs, each of 10 million gallons capacity, on hills close to city.—*Geo. C. Bunker.*

When Hot Water Backs into Service Pipes. C. B. JACKSON. Fire & Water Eng., 74: 1237, December 12, 1923. On account of great number of hot water boilers operating on any system, dangers of property loss and also probable loss of life are too great to justify installation of check valves generally. In case there should be occasion to install check valve for purpose of correcting evil known to exist uncorrected by consumer, serving company should by all means give definite notice when such check valve is to be installed. Case of Henri Bourie vs. Spring Valley water Co., 8-California, Appellate Report, page 588, is cited as example.—*Geo. C. Bunker.*

Advantages of the Oil Engine for Water Works Use. F. JOHNSTONE-TAYLOR. Fire & Water Eng., 74: 1244, December 12, 1923. The gas engine is used in Britain for pump operation to large extent. Operating on towns' gas it is ideal standby unit. It can be started up instantly at any time and there is no capital sunk in a producer. In Britain however, towns' gas on account of its cost is rarely used, producers being almost invariably installed. The gas engine—producer combination is a type of prime mover built by numerous

firms in Britain, and, suitable coal being available, is very popular, both at home and in colonies. Well designed gas engine and producer will give one B. H. P. hour on well under ¾ pound good anthracite coal. Engineers have come to realize that for small units, steam cannot compare for efficiency with internal combustion engine. Latter has in recent years been vastly improved; especially those of airless injection type. They have all the advantages of the Diesel with none of its disadvantages. The hot bulb engine is also coming into favor on account of its great simplicity, but so far its fuel consumption does not compare with either the Diesel or the four stroke heavy oil engine. The oil engine, in one form or another, presents such outstanding advantages that it would seem that most future developments will take place on these lines. Fuel consumption for pumps driven by oil engines is given for installations in five water works. Illus.—*Geo. C. Bunker.*

Methods and Cost of Thawing Water Services. Eng. Contrg., 61: 560–2, 1924.—*Langdon Pearse.*

Vegetation on Earth Dam Slopes. Bull. Miami Conservancy District, 1923; Eng. Contrg., 61: 601, 1924. Experiments with growth on lean soil or gravel show sweet clover and alfalfa the best.—*Langdon Pearse.*

Seasonal Flow in Aqueduct. Eng. Contrg., 61: 601, 1924. The Sudbury, Mass., aqueduct carries more in winter than in summer.—*Langdon Pearse.*

New Well Water System of Winter Garden, Fla. L. H. King. Eng. Contrg., 61: 565–6, 1924. Well installation for 2000 population.—*Langdon Pearse.*

Method of Laying 20-in. Water Main across River. John Taylor. Eng. Contrg., 61: 599–601, 1924.—*Langdon Pearse.*

Experiences with Trench Sheeting. C. R. Gow. Boston Soc. C. E., December, 1923; Eng. Contrg., 61: 596–8, 1924.—*Langdon Pearse.*

Cost of Automobile Operation by a Water Department. Ann. Rep. Water Dept. Pasadena, Cal., 1923; Eng. Contrg., 61: 767, 1924. Cost per hour was $0.19.—*Langdon Pearse.*

Cost of Water Main Construction at Pasadena. Ann. Rep. Water Dept., 1923; Eng. Contrg., 61: 767, 1924. Costs are given for 2, 4, 6, 12, 20 inch pipe in detail.—*Langdon Pearse.*

Flow of Water through Sluices and Scale Model. H. E. Hurst and D. A. F. Watt. Eng. Contrg., 61: 784–5, 1924. Experiments on models of Assuan dam are detailed.—*Langdon Pearse.*

How Gary Water Co. Handle Main Extension. William Luscombe. Ind. San. & W. S. Assn., 1924; Eng. Contrg., 61: 788, 1924.—*Langdon Pearse.*

Welland Water Supply Problem. WILLIS CHIPMAN. Can Engr., 46: 342, 1924. Recommendations for changes in works necessitated by enlargement of Welland canal.—*Langdon Pearse.*

Extension to Water Works, Brockville, Ont. Can. Engr., 46: 349–50, 1924. Two gasoline driven centrifugal pumps, installed for standby, help reduce coal bill.—*Langdon Pearse.*

Per Capita Water Consumption in Metropolitan Districts. F. E. MERRILL. Ann. Water Rep. Somerville, Mass., 1923; Eng. Contrg., 62: 84, 1924. Per capita use of towns in Metropolitan District of Mass. varied from 41 to 127 gallons daily.—*Langdon Pearse.*

An Experimental Study of Air Lift Pumps. C. N. WARD AND L. H. KESSLER. Bull. Univ. Wis., 9: 4; Eng. Contrg., 61: 1273–8, 1924. Complete details are given of tests, with conclusions and diagrams of loss of head—velocity.—*Langdon Pearse.* (*Courtesy Chem. Abst.*)

Report on Philadelphia's Water Supply. J. W. SMITH, ALLEN HAZEN, G. W. FULLER, J. F. HASSKARL. Pub. Works, 55: 188–9, May, 1924. Recommends turning Torresdale pre-filters into rapid filters, to supply slow sand filters, making thorough double filtration, for half the supply. Recommends storage on Tohickon and Perkiomen creeks, to replace Schuylkill, at cost of $91,500,000, for balance of supply. Provision is made for 500 million gallons per 24 hours from all sources.—*Langdon Pearse.* (*Courtesy Chem. Abst.*)

Study of Comparative Height Growth of Six Planted Species. H. C. BELYEA. Journal of Forestry, 22: 4,389, April, 1924. Field measurements of plantations of Great Bear Water Co., near Fulton, N. Y., planted 1908–10, measured 1923. In order of increasing height Western Yellow Pine, White Pine, Red Pine, Norway Spruce, Siberian Larch, and Scotch Pine. Western Y. P. is not a success. Red Pine appears thriftiest. Observations based on 300 to 750 trees of each species.—*G. R. Taylor.*

Early Development of White and Red Pine Plantations. RALPH C. HAWLEY. Journal of Forestry, 22: 3, 275–81, March, 1924. Nineteen hundred acres planted by New Haven Water Co., under supervision of Yale School of Forestry. Describes character of land, methods and cost of planting, and measurements of growth. Advises planting more Red than White, because of freedom from insect attacks.—*G. R. Taylor.*

The Erosion Problem. C. G. BATES. Journal of Forestry, 22: 5, 498–505, May, 1924. Discussion of erosion as it affects stream and reservoirs. One stream in flood carried 85,000 cubic yards water and 221,000 cubic yards detritus. Cites experiments on Wagon Wheel Gap, where run-off from denuded watershed has increased 23 per cent since denudation: no decrease in flow of this stream even during summer months. Logging roads, rather than fire, a principal cause of erosion on cut-over areas.—*G. R. Taylor.*

Self Corrosion of Lead Cable Sheath. F. O. Anderegg and R. V. Achatz. Eng. Expt. Station, Purdue University, Bull. 18: 45 pp., July, 1924. Of interest to water works men, as data relative to commercially pure lead sheath are applicable to lead service pipe. Deals only with type of corrosion designated in report of American Committee on Electrolysis as "Self-Corrosion," which is term applied when pipe, or other mass of impure or heterogeneous metal, buried in soil is corroded by electrolysis due to local action, without any external source of current. Self-corrosion may also be due to direct chemical action. Study covers two series of investigations; one in field, and one in laboratory, between the results of which concordance was, in general, obtained. Good understanding of causes and conditions for corrosion was gained and an accelerated test developed which furnishes good indication of probable extent of corrosion in given soil of given sample of sheath material. *Causes of corrosion.* In general, most important cause is presence in soil of organic matter, decomposition of which produces acids tending to attack material of cable sheath. Corrosion product was obtained from about 80 per cent of cables inspected; in nearly every case tests for acetic acid were obtained. Decaying wood and vegetable matter produce this acid; and hence it is inadvisable to use untreated wood boards as protection for cable. Alkali in form of limestone, concrete, gypsum, etc., is also direct cause of corrosion in some cases, and is likely in all cases to increase corrosion rate. Salts, particularly common salt, may also be cause of corrosion, due to local galvanic action. *Factors which increase rate of corrosion.* In general, rate at which corrosion takes place increases with amount of organic matter in soil: a conclusion supported both by field and laboratory observations. In laboratory, order of decreasing corrosiveness was found to be (1) muck, (2) cinders, (3) sand, (4) clay. Corrosion is likely to take place more rapidly in soils containing limestone and other calcareous matter, or where cinders are present. It is more rapid in poorly drained than in well-drained soils. *Effect of sheath compositions.* Both field and laboratory data indicate that tin-lead alloy sheath is much more resistant than pure lead, while antimony-lead, on the other hand, is less resistant. This seems to be due to fact that corrosion starts in intercrystalline spaces. *Prevention of corrosion.* Only means of preventing corrosion is by separation of the cable sheath from soil. In construction using conduit this is done effectively by clay duct, with almost complete absence of corrosion. Limited experience with pitch or asphaltic coverings indicates that corrosion will be prevented if covering complete and continuous. Use of concrete, limestone, or untreated wood, in direct contact with, or in vicinity of sheath, should be avoided. Under discussion of protective covering of cable buried directly in the earth, authors state that among those suggested, or used, are thin covering of sand, wooden strips, building paper, crushed limestone, concrete slabs, etc. Most of companies using buried cable have abandoned use of these protective coverings as they have felt benefit derived from them was not sufficient to justify added cost. Compound recently placed on market which has found wide sale is apparently pitch, or asphaltic substance, with good adherence to cable. As far as is known this type of compound does not contain anything injurious to cable sheath. Similar compounds have been used for sealing potheads for many years without

trouble. If compound is coated over cable in such a way as to prevent direct contact between sheath and soil, it is probable that it will prevent corrosion. Bibliography of 63 papers. Illus.—*Geo. C. Bunker.*

Standard Specifications for Concrete and Reinforced Concrete. Report of Joint Committees. Proc. American Soc. Civ. Eng., 50: 8, 1153–1285, October, 1924. Comprehensive and detailed specifications covering general conditions affecting use of concrete and reinforced concrete. Affiliated committees of American Society of Civil Engineers, American Society for Testing Materials, American Railway Engineering Association, American Concrete Institute and Portland Cement Association.—*John R. Baylis.*

How the Chemical Engineer Tackles the Water Problems of a Railroad. William M. Barr. Chem. and Met. Eng., 31: 9, 348–51, September 1, 1924. Water treatment for locomotives usually involves precipitation of calcium carbonate. Reactions are reversible, and velocity depends much on temperature and pressure. Reaction temperatures of water when treated range from slightly above 0° to 38°C. Impractical to heat water to hasten reaction. Removal of scale-forming salts is only part of problems; many waters are unsuitable for locomotives after scale-forming ingredients have been removed. Greatest difficulty encountered with water from locomotive engineers' standpoint is foaming, which invariably results is slowing down speed. Good practice to carry water treatment as close to end point as possible without having excess of caustic or carbonate alkalinity. Such treatment results in minimum complaints from locomotive engineers and causes little scale. If dissolved gases could be eliminated and hydrogen-ion concentration held to minimum, corrosion would be small. Possible to run passenger engines 600 to 700 miles in normally bad water districts. Type of softener is of great importance. In order to secure proper settling of sludge, rise of water in softener should not exceed 10 feet per hour. With 30 minutes reaction time and 5 hours settling, some waters can be treated as low as 55 p.p.m. while others will not go nearly so low. Excessive amounts of lime and soda ash are avoided, thus preventing incrustation of injectors and holding foaming tendency to minimum. Zeolite softeners, while giving zero hardness, exchange calcium and magnesium for sodium, thereby increasing foaming tendencies. Cost of sodium aluminate is excessive. Combined with lime and soda ash, it gave hardness of 70 p.p.m. as compared with 90 p.p.m. with straight lime and soda ash.—*John R. Baylis.*

Treating Industrial Wastes. Frank Bachmann and E. B. Besselievre. Chem. and Met. Eng., 31: 10, 386–7, September, 1924. Industries should bear burden of rendering their wastes harmless before discharging into streams, and treatment of wastes is becoming recognized necessity of plant operation. Type or degree of treatment required depends upon use of the streams receiving discharge. When discharge enters municipal sewer systems leading to plants for sewage treatment, measures must frequently be taken to eliminate constituents that might affect the treatment. In some cases chemical precipitation is absolutely necessary for proper treatment of waste. Removal of sludge may be periodical and manual, or continuous and mechanical. Latter is the more economical method in the average plant.—*John R. Baylis.*

NEW BOOKS

Cours d'Epuration des Eaux et Assainissement des Cours d'Eau. (3e partie du cours hydraulique). DIENERT, 393 pages, 6 figures, 2 plates, L'Ecole Speciale des Travaux Publiques, Leon Eyrolles, director, rue du Sommerard, Paris (5e). 24 francs.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Annales des Services Techniques d'Hygiene de la Ville de Paris: Surveillance des Eaux pendent 1922. M. F. DIENERT, chef du srevice. Illustrated brochure, 8vo, 106 pages, Gauthier-Villars et cie, publishers, 55 Quai des Grands Augustins, Paris (6e).—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Notions d'Hydrologie Appliquée a l'Hygiene; Bacteriologie des Eaux. A. GUILLERD, sous chef du Surveillance des Eaux d'Alimentation de Paris, etc. Preface by Dr. F. Bordas, 8vo, 246 pages, 60 figures, Librarie Polytechnique Ch. Beranger, 15, rue des Saints Pères, Paris (6e).—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Pulverised Fuel. W. F. GOODRICH. Charles Griffin and Co. 10s. 10d. 215 pp. Munic, Eng., 73: 390, 1924. Review.—*R. E. Thompson.*

The Principles of Irrigation Engineering. F. E. KANTHACK. Longmans, Green and Co. 35s. 9d. 299 pp. Munic. Eng., 73: 696, 1924. Review.—*R. E. Thompson.*

Pulverised Fuel and Efficient Steam Generation. D. BROWNLIE. 184 pp. Munic. Eng. 74: 103, 1924. Review.—*R. E. Thompson.*

Elements of Water Bacteriology. S. C. PRESCOTT AND C. E. A. WINSLOW. Chapman and Hall. 12s. 211 pp. Munic. Eng., 14: 178, 1924. Review.—*R. E. Thompson.*

The Use of Copper and Brass for Domestic Water Services. Copper and Brass Extended Uses Council, Birmingham. Munic. Eng., 74: 220, 1924. Review.—*R. E. Thompson.*

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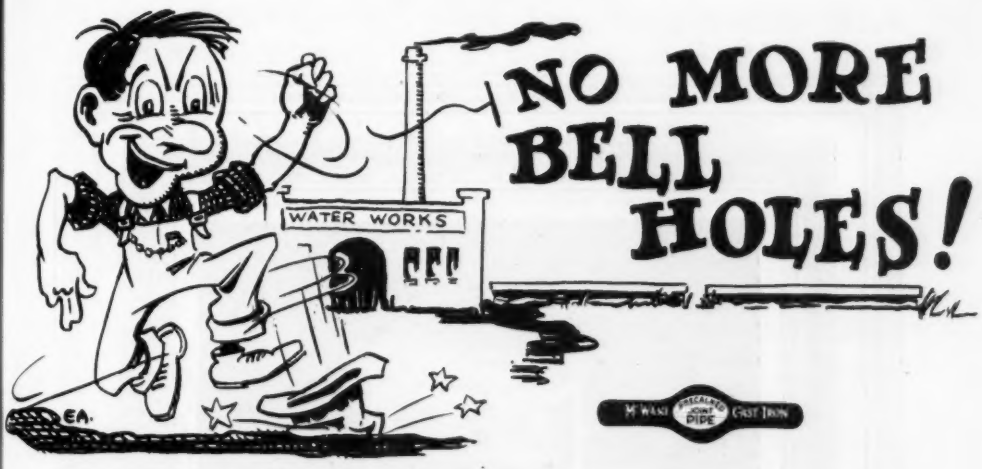

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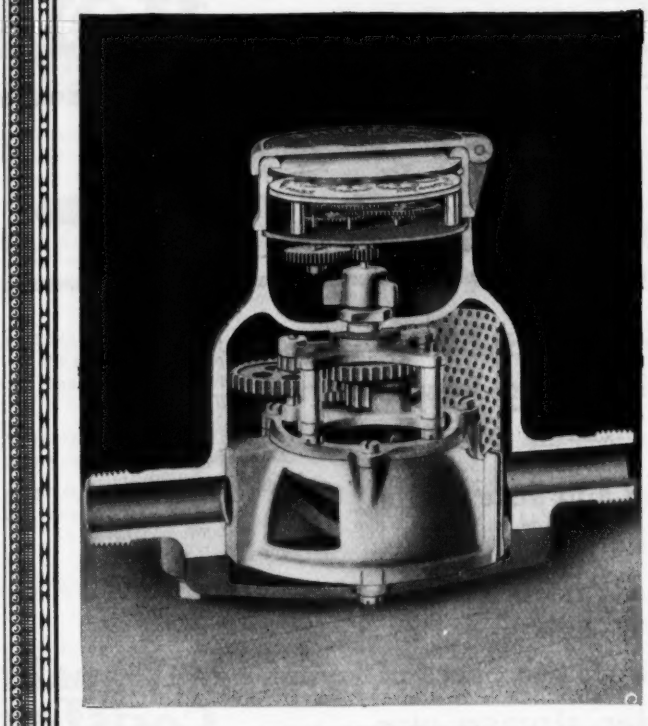

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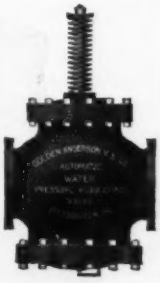

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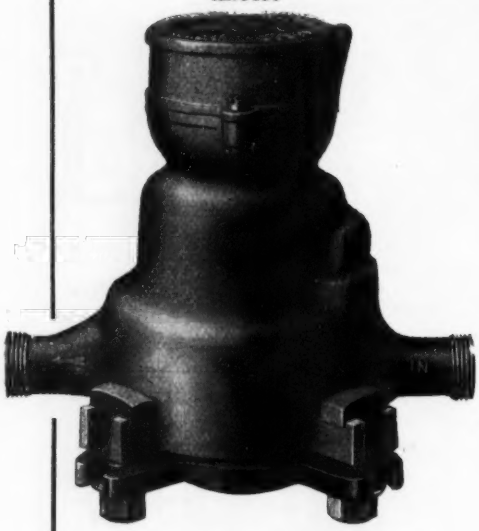

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Both the ARCTIC and the TROPIC will be equipped with a COMPLETELY ENCLOSED intermediate train RUNNING IN OIL, if desired.

Write or wire nearest office for full and complete information

Please note change of address

PITTSBURGH METER COMPANY

General Office and Works: 7800 Susquehanna St., Pittsburgh, Pa.

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Chicago, 5 So. Wabash Avenue
Kansas City, Mutual Building
Columbia, S. C., 1433 Main Street
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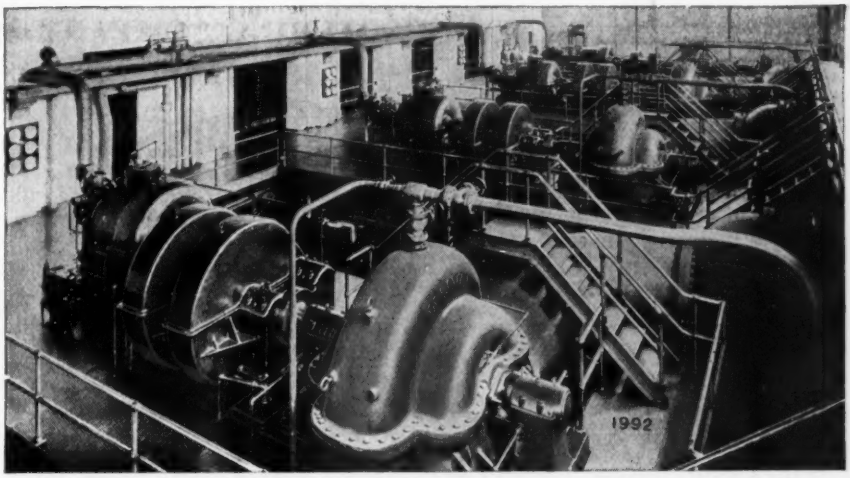

600,000,000 Gallons Per Day
For Cleveland

TEN years ago the City of Cleveland installed at the Kirtland Station a thirty million gallon per day De Laval geared turbine driven pump, which on test developed the for that time record-breaking duty of 152 million foot pounds per 1000 lbs. of steam.

Subsequently the Division Street Station was equipped with the four De Laval units shown above, of which two supply 100 MGD and one 60 MGD at 50 ft. head, while the fourth pumps 20 MGD against 400 ft.

Five more De Laval geared turbine driven pumps of the most modern type have been purchased by the City of Cleveland for the new Fairmount Station. The turbines will operate on steam at 300 lbs. gage with 200 degrees Fahrenheit superheat and the pumps will deliver 20 MGD each, three against 400 ft. head and two against 154 ft. In addition there are three De Laval low head pumps, one of 50 MGD and two of 75 MGD, raising water to the filter basin against a maximum head of 85 ft.

The condensate pumps and stokers in this station are driven by De Laval water turbines, while two De Laval geared turbines drive the forced draft fans.

Four billion gallon per day capacity of De Laval Pumps installed in the water works stations of American cities is good evidence that

DE LAVAL GEARED TURBINE DRIVEN CENTRIFUGAL PUMPS DELIVER WATER AT THE LOWEST TOTAL COST, INCLUDING FUEL, ATTENDANCE, UPKEEP AND CAPITAL CHARGES.

Our engineers will be glad to make recommendations and to offer guarantees after a careful study of your pumping requirements. Ask for Special Publication W-94.

De Laval
Steam Turbine Co., Trenton, N.J.

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340

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Manufacturers of Water Works Specialties as Follows:

Smith Tapping Machines for making connections 2″ to 36″ inclusive, without shutting off the pressure.

Valve Inserting Machines, for inserting Valves, 4″ to 20″ inclusive, in existing lines of pipe without shutting off the pressure. With this Machine Valves can be installed in front of Hydrants.

Corporation Tapping Machine, for inserting Cocks under pressure. Light, durable and absolutely guaranteed.

Pipe Cutting Machines of various sizes for cutting 4″ to 54″ pipe.

Also manufacturers of High Grade Water Gates, Fire Hydrants, for both low and high pressure service, Brass Goods of every description and various other Water Works Specialties.

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One does not have to be an expert mathematician to figure out that a clogged water main calls for a stronger pressure and that in turn calls for more coal—and literally burning up money. We can show you how to get dollar for dollar value out of every ton of coal. We can show you how to clean the water mains quickly and cheaply. Send us your address—that's all we ask of you.

National Water Main Cleaning Co.
NEW YORK CITY

Pasadena Reduced Its Water Consumption 30%--By Metering

WATER, delivered to the city consumer, costs approximately $80 per 1,000,000 gallons. That figure is the average of twenty-eight cities. A million gallons sounds like a lot, but it doesn't go very far in the community of any size.

Pasadena, for instance, with its population of 45,000 was using nearly 8,000,000 gallons daily before meters were installed. Just how much of that was wasted is difficult to say. The fact that metering reduced the daily per capita consumption from 170 gallons to 120 gallons points its own conclusion.

Metering in Pasadena reduced the station pumpage over 41 per cent. It effected a reduction in water consumption of over 2,000,000 gallons daily. Figured on the average basis of $80 per 1,000,000 gallons it resulted in an operative saving of $63,000 per year for the city. In addition, it automatically increased the service capacity of the present water supply system by 30 per cent.

Eventually every community will recognize the necessity and the economy of conserving water. They will meet that necessity by metering. Meters do not limit the legitimate use of water—but they stop waste. Meters increase the storage in its relation to a given population—they definitely conserve water resources.

AQUAFAX is a 56-page monthly magazine giving current news and accurate information regarding the conservation of water. The regular subscription price is $3.00 per year, but it will be sent free upon request to engineers, municipal heads and civic organizations.

METER maintenance charges consist largely of labor costs—these have been reduced to a minimum in the Trident. Trident parts are interchangeable. Every improvement which has been made in Neptune Meter construction may thus be applied to meters already in service. A Neptune Trident Meter need never become obsolete.

Send for a copy of the new 86-page book illustrating and describing all types and sizes of Neptune Trident Meters.

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Pioneers in Meter Progress

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BY

GEORGE A. JOHNSON

A Few Copies Still Available at the Secretary's Office

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DON'T FORGET

that the Association has headquarters in New York City, where the Secretary is ready to be of service to the members when possible. When in the City call at the office—make it your headquarters. Have your mail directed there if you have not made hotel reservations, and then come to the office for it, or direct the Secretary where you wish it sent. Jot the address and telephone number down in your note book NOW, so as to have it when needed.

AMERICAN WATER WORKS ASSOCIATION

170 Broadway Telephone Cortlandt 7718

NASH TYPE K
DISC STYLE
WATER METERS

WELL DESIGNED
CAREFULLY BUILT
ACCURATE
SUBSTANTIAL
SATISFACTORY

We have been making disc meters for over thirty-five years. Every improvement that experience and experiment have proved to be valuable we have incorporated in our NASH Type K. We are confident that there is no better disc meter made.

WITH OR WITHOUT FROST PROTECTION FEATURE

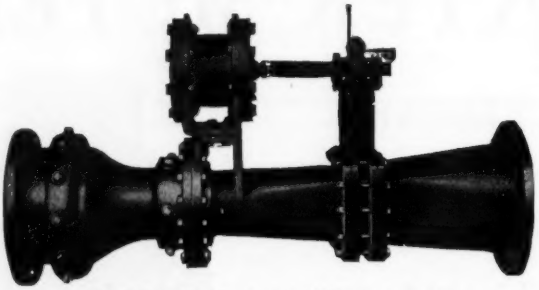
Our patented breakable flange washer is an efficient and practical device for protecting the working parts of the meter in case of freezing. Where frost damage is not anticipated we can furnish a "Dixie" type without the frost washers.

NASH Type K is fully described and illustrated in circular 200. Send your name and address and we will promptly forward you a copy. (Ask for 201 if you use "Dixies.")

NATIONAL METER COMPANY
299 Broadway, New York

BRANCHES IN ALL PRINCIPAL CITIES

Saving Wash Water in the Filtration Plant



VENTURI CONTROLLER TUBE

The longer filter beds can be kept in operation the less amount of filtered water required for washing and the less pumping required.

Such savings may total a large amount in a year's time.

The shape of the Venturi Effluent Controller Tube produces a true Venturi restoration of pressure between throat and outlet; the friction loss is almost negligible---only 6″ to 12″ of water.

VENTURI CONTROLLERS MEAN MORE FILTERED WATER PER DOLLAR

BUILDERS IRON FOUNDRY

Builders of the Venturi for 33 years

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Hand and Power Outfits

HEAVY DUTY One or Two Pump UNITS
with 3-inch or 4-inch Suction

Insist on GENUINE EDSON Pumps, Suction Hose, Diaphragm with Bead, etc.

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Write for descriptive booklet and any particular information desired

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W. P. Taylor Company, Successor
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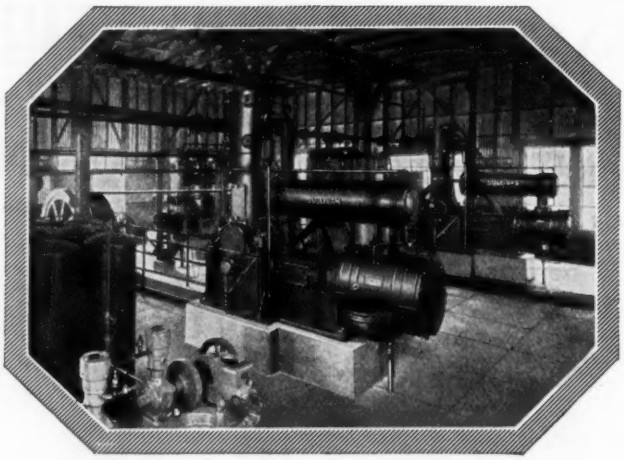


Air Lift at El Paso

Gets More Water, More Cheaply

The Southern Pacific Railroad yards and shops at El Paso have replaced mechanical pumping by

Sullivan Air Lift

Result: More water, lower cost, steady supply.

NOTE THESE FIGURES:

	Well No. 1	Well No. 2
Depth of well, ft.	863	869
Lift, ft.	282	266
Gals. pr. min.	731	659
Gals. Fuel Oil pr. hr.	11.7	11.6
Cost Fuel Oil at 5 cents pr gal. pr. hr.	$0.585	$0.58
Gals. pumped pr. hr.	43,860	39,500
Cost Fuel Oil per 1000 gals.	$0.0133	$0.0147

The air lifts are supplied by two 20-12 x 14 Sullivan Angle Compound Compressors belted to oil engines, as shown in the upper photograph.

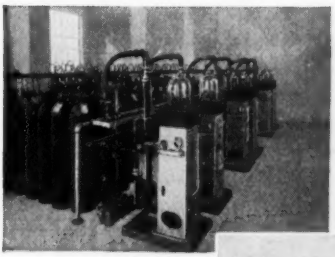
The water is carried 4 miles to the shops and yards at El Paso.

Read a full account of this development in Railway Engineering & Maintenance for March, 1924, or send to us for a reprint in Mine and Quarry for July, 1924.

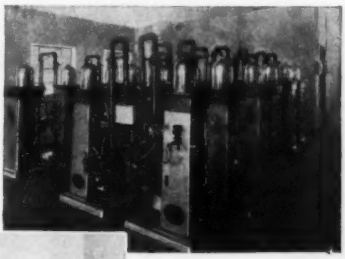
If interested in well water supply, write for new Bulletin 4271-H.

Sullivan Machinery Company
136 South Michigan Ave.
Chicago

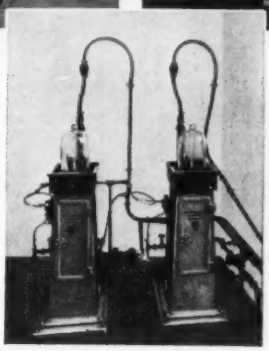
Chlorine in Sewage Purification



At the Westerly Sewage Disposal Works at Cleveland, six Pedestal Type Chlorinators are installed to chlorinate the Imhoff Tank Effluent.



Eighteen Pedestal Type Chlorinators installed at the Easterly Sewage Disposal Works, Cleveland, Ohio. "The Largest Chlorinator installation in the World." Capacity six and one-half Tons of Liquid Chlorine a day.



New York City uses the Pedestal Type Chlorinator at the Midland Beach Sewage Disposal Plant.

NOT ONLY has the Chlorination of water become standard practice in a large portion of the world but the value of Chlorine in Sewage Purification as a germicide, deodorant, and oxidizing agent is increasingly evident.

Sanitarians recognize that disease laden sewage should not be discharged into water used for drinking or bathing until the harmful germ life in the sewage has been destroyed.

Here W&T apparatus is particularly applicable. We invite inquiries concerning the use of our equipment in the Purification of Sewage.

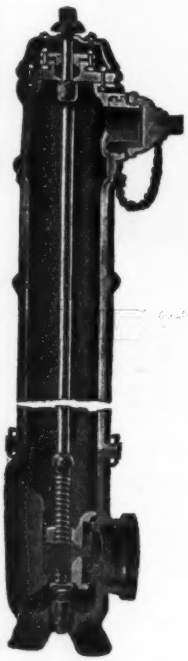
"The only safe Water is a Sterilized Water"

TECHNICAL PUBLICATION NUMBER 42 "CHLORINE IN SEWAGE PURIFICATION" WILL BE MAILED ON REQUEST

WALLACE & TIERNAN
COMPANY, INCORPORATED
Manufacturers of Chlorine Control Apparatus
NEWARK NEW JERSEY

The Ludlow Valve Mfg. Co.

MANUFACTURERS OF



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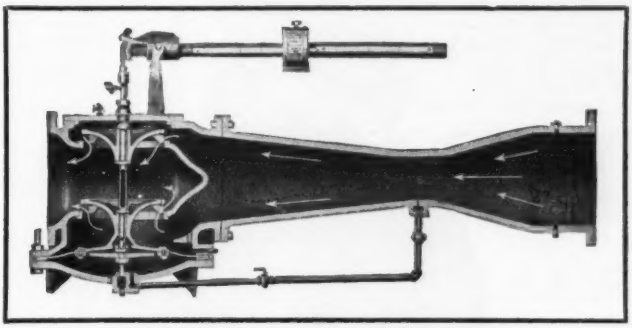

Cross section of a Simplex Controller

Direct Acting, Keeps its Adjustment, Eliminates Surging and Breaking the Filter Bed, Consequent High Bacterial Efficiency.

For use where Water or other liquids are filtered either by pressure or gravity—especially where the rate of filtration must be kept constant.

Used successfully by ALL the leading Filter Companies and specified by the most prominent Consulting Engineers.

The Simplex is the Only Commonly Used and Successful Direct-Acting Controller on the Market.

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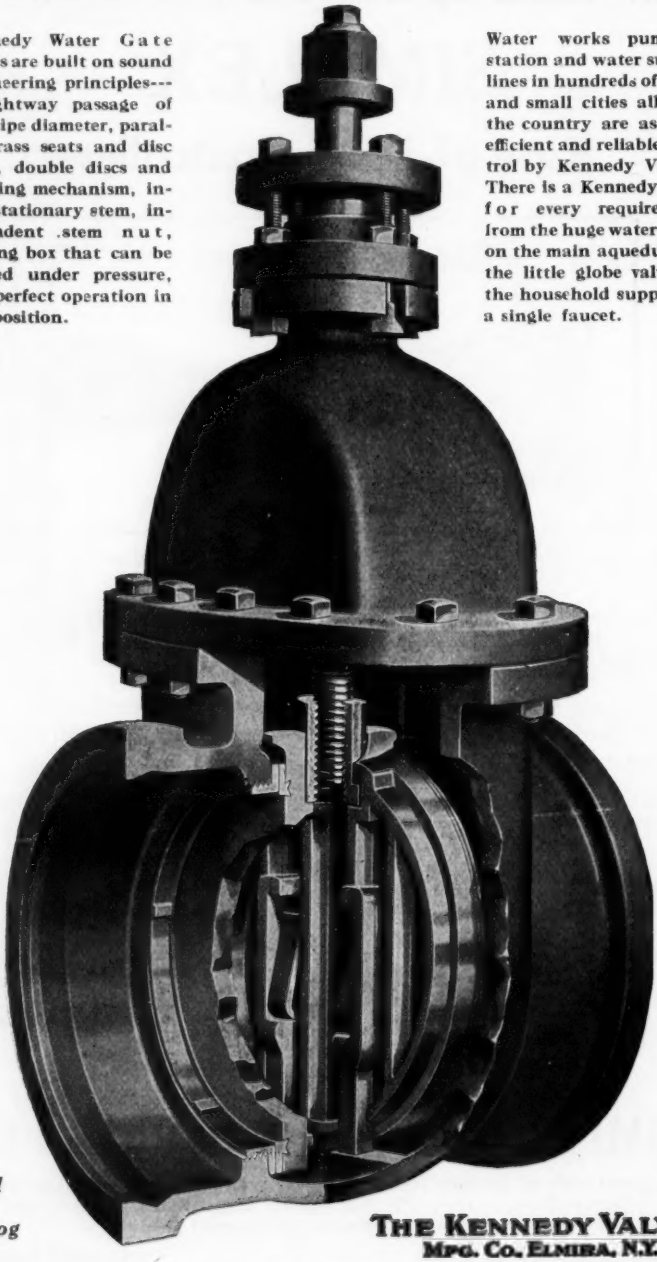
Kennedy Water Gate Valves are built on sound engineering principles---straightway passage of full pipe diameter, parallel brass seats and disc faces, double discs and wedging mechanism, inside stationary stem, independent stem nut, stuffing box that can be packed under pressure, and perfect operation in any position.



Water works pumping station and water supply lines in hundreds of large and small cities all over the country are assured efficient and reliable control by Kennedy Valves. There is a Kennedy type for every requirement from the huge water gates on the main aqueduct to the little globe valve on the household supply to a single faucet.

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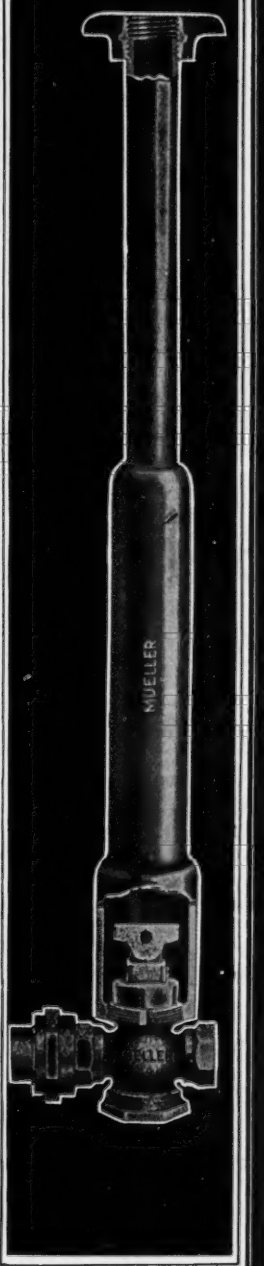

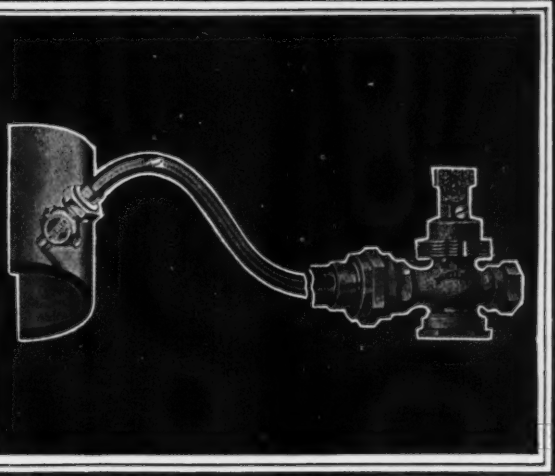

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Goose Necks. Curb Cocks Extension Service Boxes

The three items here shown — *MUELLER* Goose Neck No. E-500, *MUELLER* Curb Cock No. E-565, and *MUELLER* Extension Service Box No. E-751—embody the *MUELLER* standards of design and precision in manufacture.

Most Water Companies recognize *MUELLER* leadership—and find that *MUELLER* equipment reduces operating costs and increases dividends.

Write us for detailed information, prices on these and other items, and proof of *MUELLER* efficiency.

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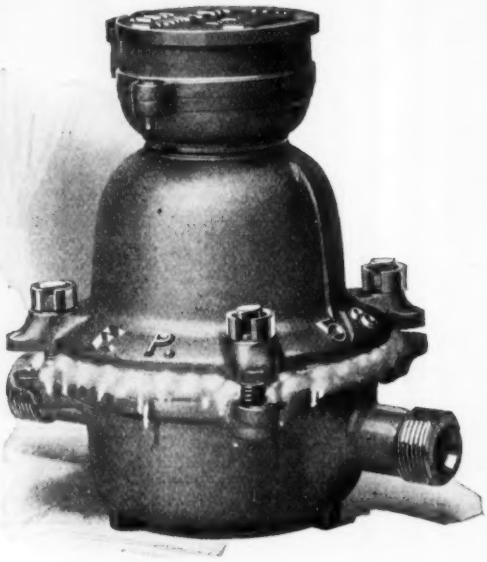

FROZEN!—but not damaged

Here is an actual photograph of a LAMBERT Frost-Proof Meter which has been frozen to an extent that would put the ordinary meter completely out of commission.

This is made possible by a patented, non-corrosive yielding bolt device which allows the upper and lower casing, disc chamber and gear train to part without damaging the meter in any way. Five minutes' labor the only repair cost.

The expense and annoyance from frozen water meters can be eliminated for all time through the installation of the LAMBERT Frost-proof.

It has been proved that the LAMBERT is the easiest water meter to take apart and put together again as well as the simplest, most reliable and accurate.

If you are interested in other types of meters, we make one for every requirement.

THOMSON METER COMPANY

100-110 BRIDGE STREET BROOKLYN, N. Y.

LAMBERT FROST PROOF METERS

512 Rub-Steel Pump Valves
under high pressure —and only two replaced in a year!

THAT is the Rub-Steel Valve record in the four pumps operating the big passenger elevators at the Exchange Place, Jersey City, Station of the Hudson & Manhattan Tubes.

These elevators, in 24-hr. per day service and heavily loaded during the rush hours, require a water pressure of 205 to 245 lb. The multiple disc brass pump valves previously used gave trouble from cracking.

Why You Should Standardize on Rub-Steel Valves

"Better than Metal because of the Rubber"
"Better than Rubber because of the Metal"

THE steel core or backbone preser es normal true form, equalizes pressure and makes valve tight closing at all points, and when one face is worn down, reversal affords a new face that is good as the first.

It's only common sense that tripled or greater life at a few cents per valve extra at the start, makes Rub-Steel Valves far cheaper in the long run than buying and placing several sets of all-rubber valves in the same period.

Here are other records of the Hudson & Manhattan R. R. Co. in their Manhattan Terminal Plant, 50 Church St., New York:

Water supply pumps:—32 Rub-Steel Valves under 185-lb. pressure. Still good after 4 years where all-rubber valves had lasted about a week.

Condensate pump:—20 Rub-Steel Valves handling hot water (212 deg. fahr.). Brass valves were never satisfactory and all-rubber valves lasted about three months. The first set of Rub-Steel Valves lasted 3 years, and a second set is now in service.

Chief Engr. Geo. H. Butler of this plant says about Rub-Steel Valves—"You put 'em in and forget 'em. No time lost for renewals." Follow his tip and you won't go wrong.

Free Sample If You Return the Coupon

All we ask in sending the free sample is that you place it among others of the all-rubber type and **keep tab on the performance. Return the coupon at once as the offer may not be repeated.**

Rubber Goods of Ultimate Economy

VOORHEES RUBBER MFG CO
TRADE MARK

Voorhees Rubber Mfg. Co., Jersey City, N. J.

I want better pump valve service and will give the Rub-Steel Valve a thorough test if you will send the free sample to meet the following conditions.

Type and size of pump_____
Size: Diam._____ Thickness_____ Hole_____
Pressure_____ lb. Temperature_____ Deg. fahr.
Fluid handled_____
What floating impurities?_____
Name_____
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Emergency orders by telephone, telegraph or letter receive prompt attention. Stocks of pipe are carried in principal cities.

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To Water Works Officials

IN placing your contract for next year's requirements of liquid chlorine, the most important things for you to consider are the container equipment you will be handling and the service your supplier will render.

Will your cylinders be cleaned and inspected at the works before each refilling? Will they be loaded with *uniform* net weights of 105 and 150 pounds? Will they be equipped with specially constructed valves which can be repacked while there is gas in the cylinders? Has the producer facilities for prompt shipments and an adequate traffic department? Does he carry warehouse stocks in all principal cities for your supply in case of emergency? Has his organization a background of trained engineers and chemists both operating and in the field?

If you specify Mathieson Liquid Chlorine—the gray cylinders with the "Eagle Thistle" label—you can give an affirmative answer to each of these important questions.

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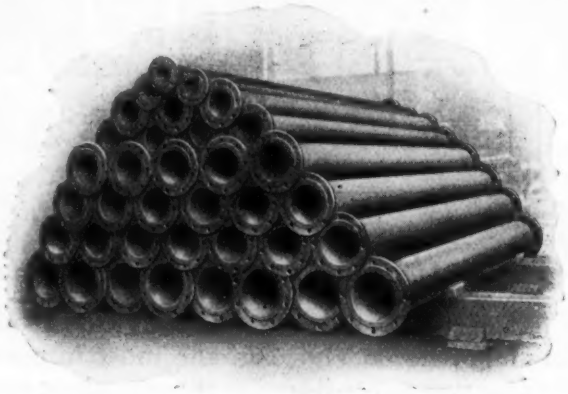

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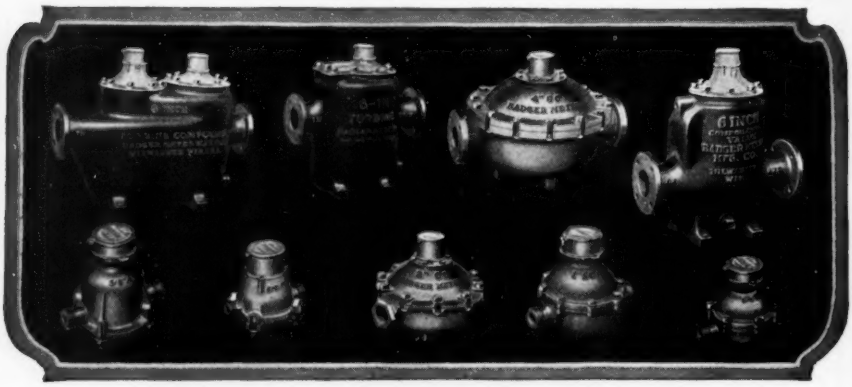
Foreign Traffic Dept.



Make the Badger Meter your Standard *for* Comparison!

Just as you judge other equipment by standards—compare water meters with the Badger. Make it your *standard for comparison.* Point for point, base your rigid inspection on the outstanding construction advantages of the *Badger.* Be assured that the meter is *fit.* That it will *tick-off accurately.* That it will *register* an impartial tolling year after year. Don't accept less.

With a complete range of meters, you can point to a Badger for every service. From the small ⅜-in. disc type to the large 6-in. turbine compound you will find the same thoroughness in design and manufacture.

Badger Meters have long been highly reputed. Chiefly because they are built right. They are designed by practical water works engineers. All parts are readily accessible and made of such metals and materials that will not corrode, nor wear unduly. They are made for long life and service.

Let the Badger prove its dependability, accuracy and earning powers. Remember they are *faithful to the end.*

Write for special bulletins.

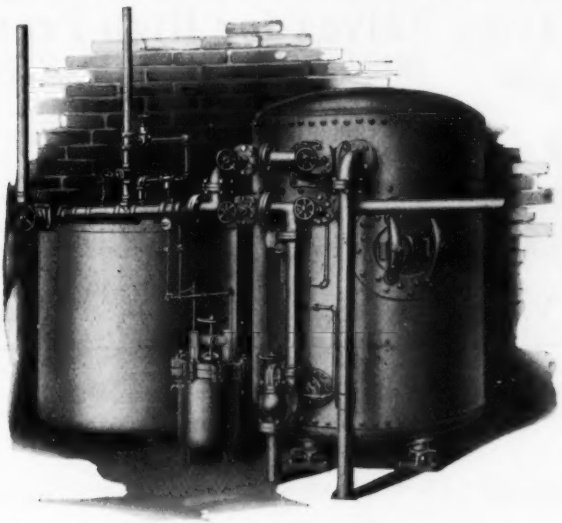
Badger Meter Mfg. Co.

841 30th Street **Branches** **Milwaukee, Wis.**

111 W. Washington Street, Chicago, Ill.
414 Interstate Bldg., Kansas City, Mo.
22 Court Street, Brooklyn, N. Y.
1621-39 Fifteenth Street, Denver, Colo.

BADGER METERS

"Faithful to the last drop"



Permutit Oil Removal Filters are built in any size to fit any condensate collecting and return system, and any desired working pressure. No special filling materials to be renewed.

Oil-Free Condensate

Reclaim your oily condensate and save those dollars that are now running to waste.

Every 100 gallons of condensate discharged to waste means a direct loss of about 4 pounds of coal. You are actually throwing away fuel.

BUT that is no longer necessary. Permutit Oil Removal Filters will remove absolutely all the oil from condensed steam, and deliver an ideal feed water. It will save its own cost in a few months' time.

Condensed steam contains oil in both suspension and as an emulsion. The ordinary oil filters and those containing so-called "special" filtering mediums, will remove oil in suspension, but they will not take out all the oil that has emulsified. The oily particles are so small that they pass right through such filters.

Permutit Oil Removal Filters are built on a different principle. They are small, compact and simple to operate, and are guaranteed to deliver an ideal boiler feed water supply. Many of the foremost paper manufacturers in the country are equipped with them, and save many tons of fuel annually.

You too can profit by this apparatus. Write for Bulletin 107. Do it today.

The Permutit Company
440 Fourth Ave. New York

Originators of Zeolite Water Softening

LARGEST EXCLUSIVE MAKERS OF WATER CONDITIONING APPARATUS IN THE WORLD

Regulating Valves for High Pressure

The regulation of Reservoirs, Stand Pipes, etc.
Steam, Water or Air

Our Regulating Valves control the High Pressure Fire Service Systems of

New York — Brooklyn
Baltimore — Jacksonville
Cleveland — Cincinnati
San Francisco

ROSS VALVE MFG. CO. **TROY, N. Y.**

The Pitt Construction Company

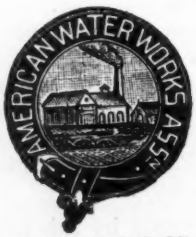
CONTRACTING ENGINEERS

Fulton Building **Pittsburgh, Pa.**

We build complete
Water Works Systems, Water Filtration Plants
Power Plants and
Sewage Treatment Plants

BADGES

THE AMERICAN WATER WORKS ASSOCIATION



OFFICIAL BADGE

The above cut is a facsimile, enlarged, of the official badge or emblem of the Association. It is of gold and blue enamel made with a pin, but can be made into a button or watch charm

The price in solid gold is $5.00 and they can be procured from the secretary. For badges address

W. M. NIESLEY, Secretary,
170 Broadway, New York, N. Y.

These badges are not to be confused with the usual convention badge, but are for everyday use.

Warren Foundry and Pipe Company

(Formerly Warren Foundry and Machine Co.)

Manufacturers of

Cast Iron Pipe

Bell and Spigot Flanged
Special Castings and Fittings, Sizes 3″ to 60″

Our Motto for 67 years "Quality First"

Sales Offices

11 Broadway, New York 201 Devonshire St., Boston, Mass.

Water · Gas Sewers Drains Railroad Culverts
Also Flexible Joint Pipe

Works: Phillipsburg, N. J.

Do You Have Obstructions In Your Service Pipes That Can Be Removed by 500 Pounds Water Pressure?

NEWARK BRASS WORKS

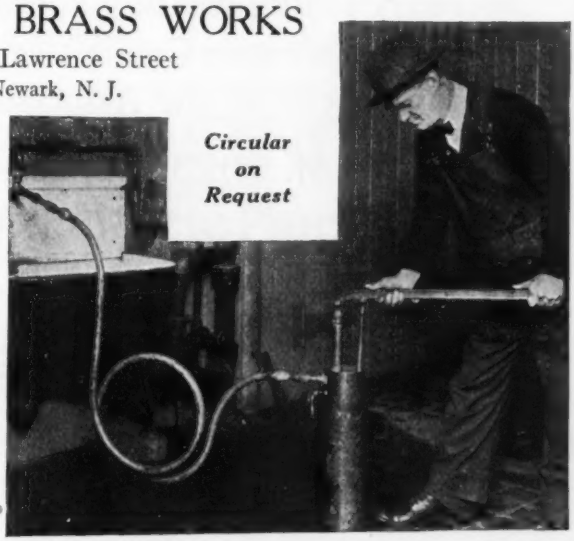
18–22 Lawrence Street
Newark, N. J.

THE LAWLESS FORCE PUMP

has been adopted by nearly 200 water works to remove such trouble.

Weight 19 lbs., Height 29 inches. Price $25.00 F. O. B. Newark, N. J. Easy to operate.

Sent on ten days' trial to any water works in U. S. A.

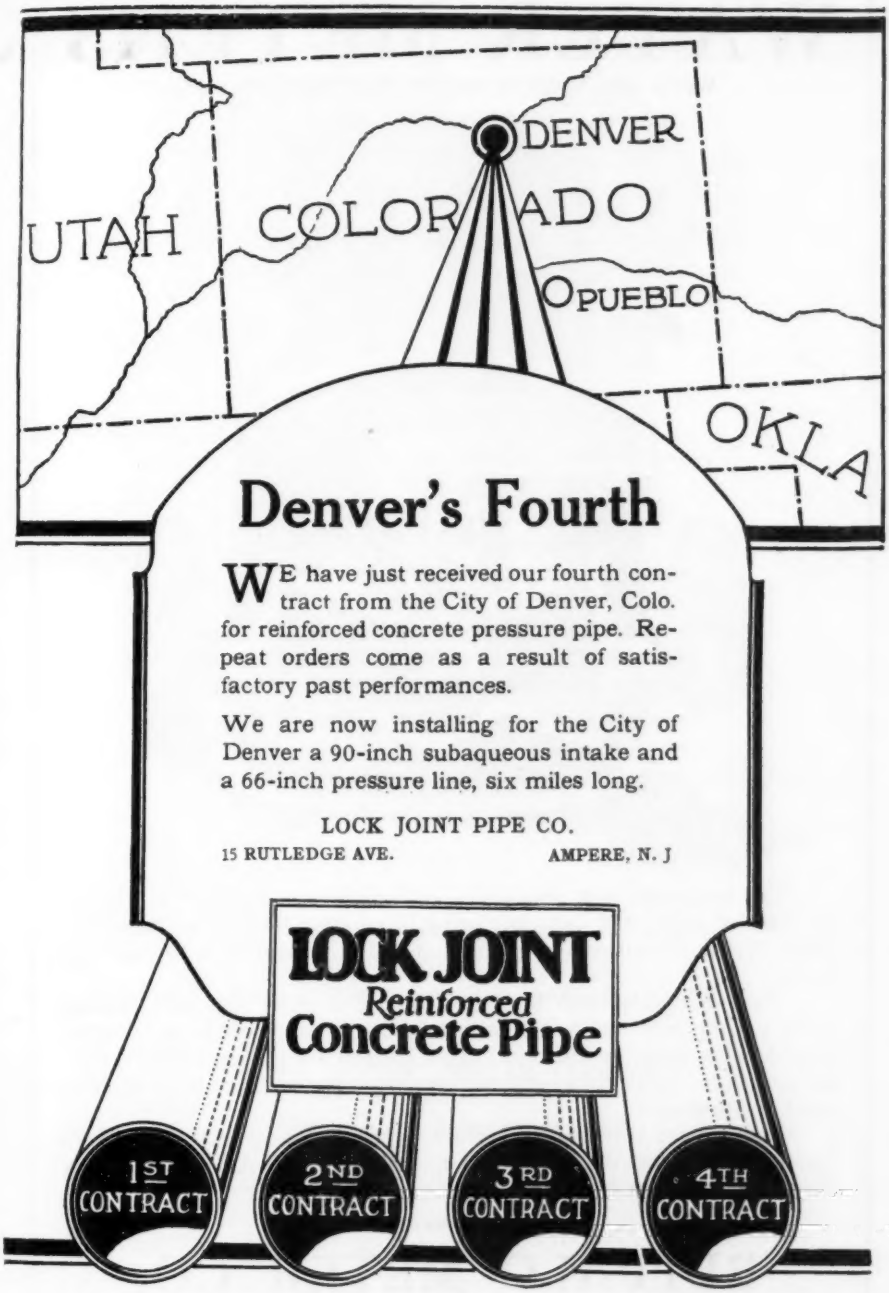


Circular on Request

IMPORTANT

OWING to an unexpectedly large number of new members since the first of January, we have run short of certain numbers of the Journal for the current year. Any members who are not interested in preserving their back numbers for January and March, 1920, 1922 and 1924, and are willing to return same to the Secretary's office will be conferring a favor upon the Executive Committee and acting to the benefit of the Association.

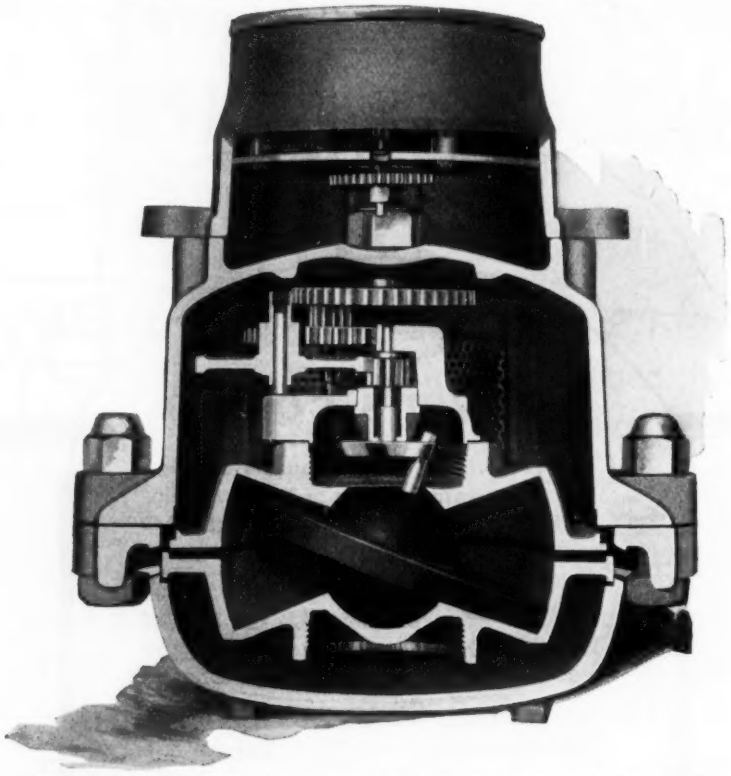
W. M. NIESLEY, Secretary,
170 Broadway,
New York City.


DENVER
UTAH
COLORADO
PUEBLO
OKLA
Denver's Fourth
WE have just received our fourth contract from the City of Denver, Colo. for reinforced concrete pressure pipe. Repeat orders come as a result of satisfactory past performances.
We are now installing for the City of Denver a 90-inch subaqueous intake and a 66-inch pressure line, six miles long.
LOCK JOINT PIPE CO.
15 RUTLEDGE AVE. AMPERE, N. J
LOCK JOINT
Reinforced
Concrete Pipe
1ST CONTRACT
2ND CONTRACT
3RD CONTRACT
4TH CONTRACT

AMERICAN AND NIAGARA

WATER METERS

WITH BREAKABLE FROST BOTTOMS (Patd.)



The sectional view shows a ⅝ inch meter cut at right angles to the line of pipe, the bottom casing burst by a "freeze up" and the parts of the intermediate gearing and disc chamber separated by the ice.

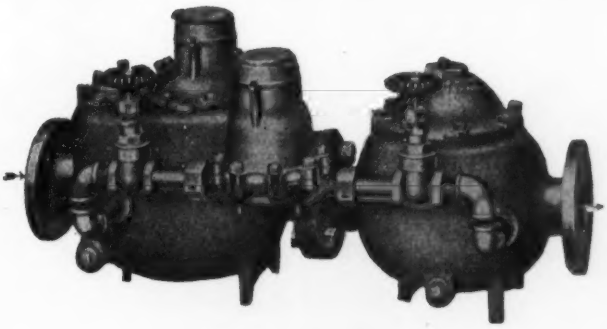
The breakable frost bottom is made of galv. cast iron but the main casing may be made of bronze or of galv. iron as may be required by service conditions. The intermediate runs on hard rubber bearings. All submerged working bearings are protected against sand and sediment.

Each meter is tested and guaranteed according to the Standard Specifications for Water Meters adopted by the American Water Works Association.

Write for catalog and prices

BUFFALO METER CO.

2914 Main St. **BUFFALO, N. Y.**



THE NEW NILO

The new improved NILO COMPOUND METER now comes equipped with a bronze body. This is a valuable addition to meter service for it eliminates the danger of corrosion and filling up due to the collecting of corrosive matter. Bronze being stronger than iron the gross weight of the meter is less, making it easier to transport, handle and install.

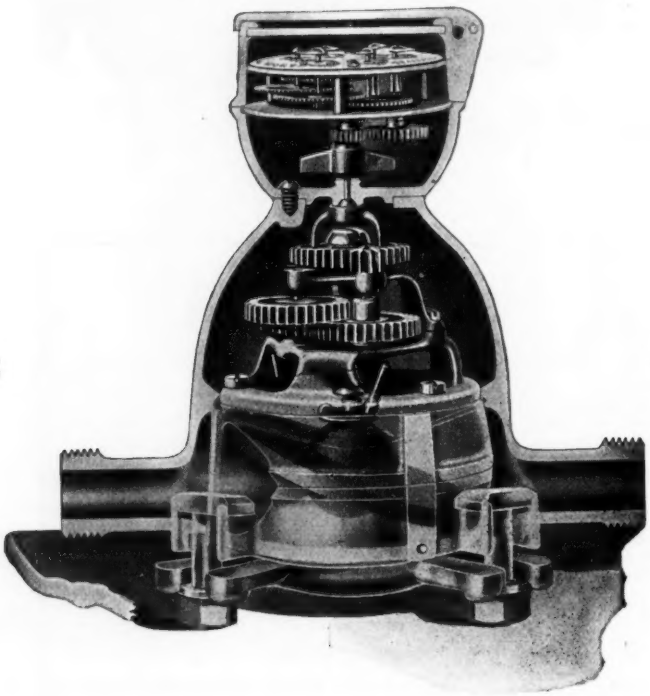
It also has two gate valves which allow the removal of the by-pass meter for cleaning or repairing without shutting off the line.

The controlling valve mechanism of the new NILO COMPOUND METER is self contained and easily detached from the main body casings.

These three improvements make the NILO, a long standing favorite, the unrivaled leader in its field.

UNION WATER METER COMPANY
Incorporated 1868
WORCESTER, MASSACHUSETTS

"WATCH DOG" WATER METERS



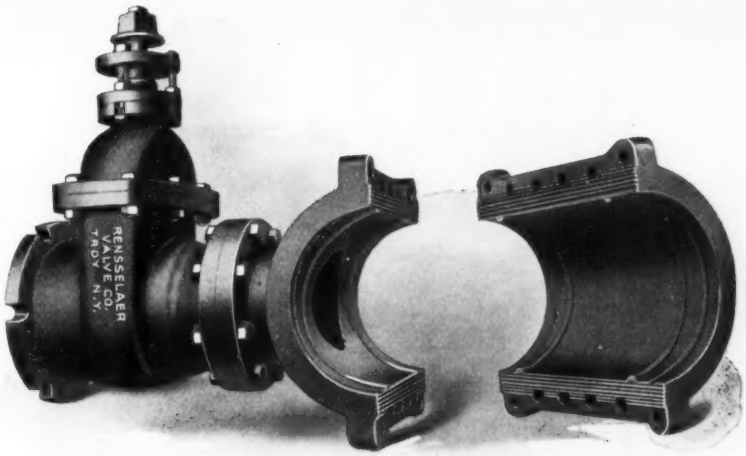
ACCURATE DURABLE

DISC, CURRENT AND COMPOUND TYPES

Inquiries Solicited

GAMON METER COMPANY

NEWARK NEW JERSEY



SOME of the POINTS OF SUPERIORITY of RENSSELAER TAPPING SLEEVES

Require ***less lead*** *for Calking*
Easier to center *on pipe* ***before pouring***
Give ***Extra Pipe Protection***
Bolts require ***No Iron Washers***
Each Size *carefully* ***designed for its Working Pressure***
Can be used with all Standard Tapping Machines

Rensselaer Tapping Sleeves are the only Sleeves on the market which are built with two Raised Rings which are a part of the Sleeve Casting itself. These Rings are used as Stops for the Hemp or Jute against which the Lead is poured to make the joint. In other types of Sleeves, without Rings, the Lead, when poured, fills entire space up to point at which cut is made.

The Raised Rings also permit easier centering of Sleeves on Pipe, also permit revolving Sleeve on pipe making it easier to tighten nuts on bolts which connect the two halves of the Sleeve.

The Bolting Flanges on all Sizes of Rensselaer Sleeves are made the full length of the Sleeve, permitting a greater number of bolts to be used back of point calked, giving greater protection to pipe at point where piece is cut out. This is especially important as in some cuts a hole nearly one-half the size of pipe is cut away.

BOOK No. 11 GIVES FURTHER PARTICULARS

RENSSELAER VALVE COMPANY
TROY, N. Y.

BRANCH OFFICES

NEW YORK, Hudson Terminal Bldg., **LOUISVILLE**, Starks Bldg.
CHICAGO, Monadnock Block **SEATTLE**, Arctic Bldg.
PITTSBURGH, Oliver Bldg. **NEW ENGLAND**, C. L. Brown, Northboro, Mass.

Tuberculosis might strike your home today

THERE is no precaution too great for you to take to protect your home and family from tuberculosis. Your children are constantly exposed to tuberculosis germs. The one effective protection against tuberculosis is the organized, co-operative campaign to stamp out the disease. It can be stamped out. Only half as many people die from tuberculosis today as died ten years ago. The organized battle against tuberculosis, carried on by the Tuberculosis Associations, has helped to save the other half.

Tuberculosis Associations are financed by the annual sale of Christmas Seals. One tangible, sure way to protect yourself and your family against tuberculosis is to buy Christmas Seals. Buy Christmas Seals. Buy as many as you can. Seal every letter, Christmas card, and Christmas parcel with Christmas Seals.

STAMP OUT TUBERCULOSIS WITH CHRISTMAS SEALS

The National, State, and Local Tuberculosis Associations of the United States

More than Fifty Years of Experience Goes Into All

EDDY

HYDRANTS AND VALVES

Built to Meet Every Exacting Requirement of Water Works Service

Type of Eddy Hydrant Popularly Used

Practical water works men instantly recognize the superior features of Eddy products. For instance, with the hydrant

A damaged valve can be replaced in a few minutes—
Positively all water hammer is eliminated—
Hydrant stems cannot be bent—
Nothing can lodge on the valve seat to prevent closing of the valve—
The Drip Rod can be removed without interfering with the hydrant in any manner—
The position of the stem of the hydrant indicates accurately the position of the valve—
Whatever can pass the valve opening will pass the standpipe—
No frost case necessary—
All of these points are explained thoroughly in our catalogue, which will pay you to study.

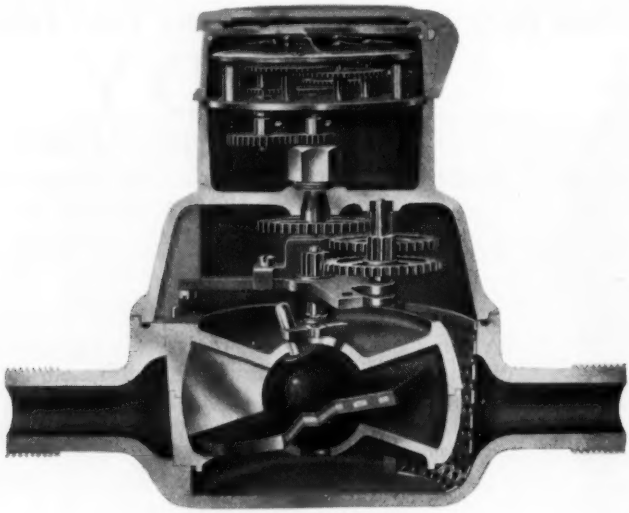
The Eddy Valve, Too

Has its distinctive and individual features. The double disc gates are free to adjust themselves in different positions every time the valve is closed, thereby keeping smooth and tight faces. And two bronze hooks on the ball loosely engage with the gates to prevent them from spreading at the top. The center bearing gates are forced to their seats with equal pressure at all points. There is a good deal more worth knowing about Eddy Valves. Further details furnished on request.

OTHER EDDY PRODUCTS

The Eddy line of water works products also includes horizontal and vertical check valves, foot valves, hydraulically operated valves, indicator posts, etc.
All goods made by the Eddy Valve Company are manufactured exclusively at Waterford, New York.
We will be pleased to furnish Catalogue on application.

EDDY VALVE COMPANY
WATERFORD, N. Y., U. S. A.



No "Backwaters" in Worthington meters

WHAT are meters built for? To measure water. Then the most important element in meter design is *the flow of the water through the meter.*

Elementary? Of course. But ingenious ideas for so-called "improvements" in design are sometimes allowed to obscure such elementary, basic necessities.

WORTHINGTON meters are designed and built with the flow of water always in mind. Every care is taken to minimize friction losses, and to see to it that there are no "pockets" or sharp angles to produce eddies or slack water.

In the WORTHINGTON compound meter, the change from the disc side to the turbine side, as the flow increases, or back again as the stream falls to a point within the capacity of the disc meter, is practically instantaneous. There is no lost motion; no failure to register during transition.

WORTHINGTON PUMP AND MACHINERY CORPORATION
115 BROADWAY, NEW YORK CITY
BRANCH OFFICES IN 24 CITIES

WORTHINGTON

0720-1

The Mark of Quality

"A Non-Skid Cushion Superior to all"

Says Chief Baird of Fresno, Cal.

"For a number of years the Firestone Cup Cushion has been considered standard equipment by this department. The service rendered has proven to be superior, particularly from a non-skid standpoint, to any other cushion tire equipment we have been able to obtain."

Veteran Fire Chiefs everywhere, who have watched Cup Cushions stand up in the hardest service for many years, join with Chief Baird in saying Cup Cushions are best for fire apparatus.

You can count on that powerful cup tread to hold safely at high speed on dangerous turns and slippery stretches. In addition, the cups take up the pounding, vibration and shock, protecting the expensive equipment.

The tough Firestone rubber retains its elasticity over long periods, giving continued protection to the apparatus and remarkable mileage in this severe service.

MOST MILES PER DOLLAR

Standard S. A. E. Sizes
for single and dual equipment

Firestone

Cup Cushion Tires

MOST MILES PER DOLLAR

DETERMINATION OF HYDROGEN ION CONCENTRATION OF WATER

with the

LAMOTTE HYDROGEN ION TESTING SET (Model 3B)

SIMPLE - ACCURATE - RAPID

A new, complete and portable outfit, containing buffers, indicators and all necessary apparatus for control work and general testing purposes. Designed for field work as well as for the laboratory. Descriptive pamphlet sent on request. Price of Set Complete $35.00 F.O.B. Baltimore.

The LaMotte Hydrogen Ion Comparator Set

A complete outfit containing set of standard tubes and other necessary equipment for determining hydrogen ion concentration.

LaMotte Standards

INDICATORS AND BUFFER SALTS: Specially prepared and standardized Indicator Dyes and Buffer Salts, covering the entire range pH 1.2-10.0, supplied in dry form or in sterile stock solutions. Standardized in strict accordance with specifications of Clark and Lubs.

COLOR STANDARDS: Prepared from buffer mixtures and the proper indicators. Supplied in 10cc ampoules for comparator work.

Illustrated catalog containing full information concerning our complete line of "LaMotte Standards" sent on request. Order direct, or through your dealer.

THE LAMOTTE CHEMICAL PRODUCTS COMPANY

McCORMICK BUILDING

BALTIMORE MARYLAND

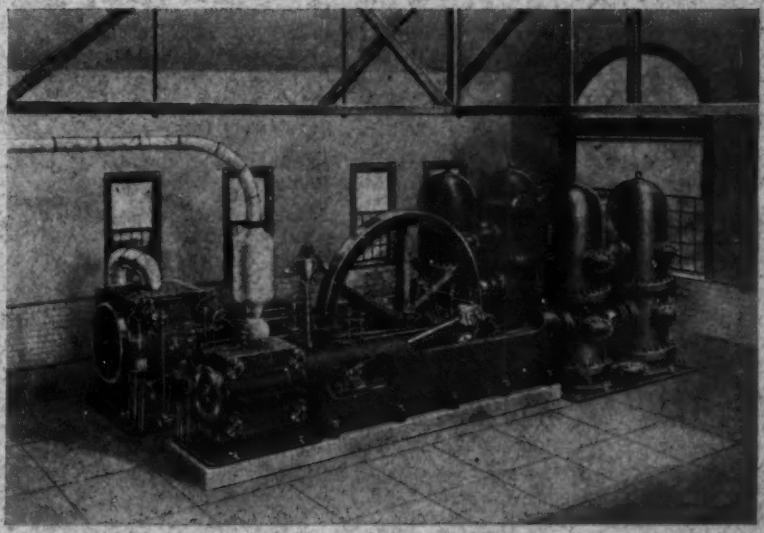
U. S. A.

MURRAY
IRON WORKS COMPANY

(Incorporated 1870)

BURLINGTON, IOWA, U. S. A.

BUILDERS OF HIGH DUTY PUMPING ENGINES



Murray High Duty Crank and Fly Wheel Pumping Engine, Opposed Type

ENGINEERS, IRON FOUNDERS, BOILER-MAKERS

MURRAY CORLISS AND UNA-FLOW ENGINES

WATER-TUBE, FIRE-TUBE, & INTERNAL-FURNACE BOILERS

COMPLETE POWER PLANTS

TWELVE REASONS WHY

YOU SHOULD USE

TRADE "LEADITE" MARK

Registered U. S. Patent Office

FOR JOINTING C. I. WATER MAINS

1—Durability. Leadite joints improve with age. Leadite was tested out for 10 years before it was placed on the market, and has now been commercialized for more than 15 years, giving it a life of over 25 years.

2—No Caulking. Leadite joints require no caulking because the Leadite adheres to the pipe, making a water-tight bond.

3—Comparative Quantities. One pound of Leadite is equivalent to four pounds of lead because Leadite is so much lighter than lead.

4—Labor Saving. Saves caulking charges and digging of large bell-holes and reduces the cost of trench pumping to the minimum, facilitating rapid completion of the work.

5—Cost. Its use saves at least 50% to 75% over lead, owing to the saving effected in material and labor.

6—Tools. As no caulking is required, fewer tools are needed.

7—Transportation. Considerable freight charges are saved because Leadite is lighter than lead, and therefore you move only one-fourth the weight of jointing material.

8—Electrolysis. Leadite resists electrolysis. However, electrical thawing apparatus may be used for thawing out frozen mains or services.

9—Fuel. Saves fuel because you melt only one pound of material instead of four and not as much heat is required to melt Leadite as is needed to melt lead. Leadite will not explode or splutter when poured into wet or damp joints.

10—Delivery. We can make prompt shipments.

11—Damage Suits. Claims for damages caused by joints blowing out are prevented because Leadite joints will not blow out under any pressure.

12—Users. Progressive water works all over the country use Leadite and thousands of miles of pipe jointed with Leadite are in service.

Leadite is the pioneer self-caulking substitute for pig lead.

Be sure it is Leadite, and accept no imitations.

THE LEADITE COMPANY, Inc.

LAND TITLE BLDG. PHILADELPHIA